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Operation/Maintenance Manual for Model 5310 Resolver/Synchro Simulator

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This manual applies to units with serial numbers GU-288 and higher.

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WARNING

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

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SERVICE BULLETIN

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Instrument Division
February 16,1990

Service Bulletin No. 145

REFERENCE: MODEL 8810 and MODEL 5310 IEEE-488 INTERFACE

North Atlantic Industries has been alerted to customer difficulties when using current model 8810 and 5310 replacements in systems originally setup using older models. There have been subtle changes made to our IEEE-488 interface design to enhance and speed operation. The following list highlights the effected areas of change.

MODEL 8810

The Model 8810 design has changed from the older one which used a 6802 microprocessor to the new design using an 8085 microprocessor. The major difference occurs in response state of the Serial Poll status byte. In the older Model 8810 the serial Poll status byte, bit 5 (DI06) is set to 1 when the front panel REM switch is not engaged (indicating Local control) and is 0 when the REM switch is engaged. The current version has front panel LED indicators and takes advantage of the local lockout capability so that it has the Serial Poll byte, bit 5 (DI06) always 0.

MODEL 5310

The model 5310 has been upgraded from an older hard logic design to the new design using an 8085 microprocessor. The affected areas of change are in its defined "Listen Only" state and how it responds to unadddressed bus commands.

The original design could cause a bus hangup if the model 5310 was inadvertently adressed for Talk responses such as Serial Poll and request for data. The current design allows for the same "Listen Only" state, however it will respond with zero for Serial Polls and with a Null for data requests.

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SECTION 1

GENERAL INFORMATION

1-1 INTRODUCTION

This manual contains a general description, installation and operating instructions, maintenance and troubleshooting procedures, replacement parts lists, and schematic diagrams for the Model 5310 Resolver/Synchro Simulator (SIM), hereinafter referred to as the Model 5310.

1-1.1 Section 1 - General Information. This section provides general physical and functional descriptions of the Model 5310. It includes a table of specifications and feature/option configuration data.

1-1.2 Section 2 - Installation. This section gives instructions for unpacking, general inspection, installation and mounting procedures, power requirements, initial setups, and a comprehensive programmable checkout procedure.

1-1.3 Section 3 - Operation. This section illustrates and explains the specific operation of controls and indicators and general unit operation. It includes procedures and programming examples for remote operation of the Model 5310 using the IEEE-488 digital interface. In addition, it describes operation and programming techniques using the IEEE-488 MATE CONTROL INTERFACE INTERMEDIATE LANGUAGE (CIIL).

1-1.4 Section 4 - Theory of Operation. This section describes functional theory of operation for the Model 5310. It provides synchro and resolver convention and includes a block diagram illustrating major system components and basic signal paths.

1-1.5 Section 5 - Maintenance. This section contains cleaning, lubrication, adjustment, and removal and replacement procedures for the Model 5310.

1-1.6 Section 6 - Troubleshooting. This section provides troubleshooting instructions and procedural flow charts for isolating faults within the Model 5310.

1-1.7 Section 7 - Parts List. This section contains replaceable parts lists, federal supply codes of manufacturers (FSCM), parts location diagrams, and a list of manufacturers of parts used for the Model 5310.

1-1.8 Section 8 - Schematic Diagrams. This section contains schematic diagrams for the Model 5310.

1-1.9 Section 9 - Update Information. As NAI continues to improve the performance of the Model 5310, corrections and modifications to the manual may be received. This section contains Product Revision Sheet (PRS) data which updates the unit to the most current configuration available.

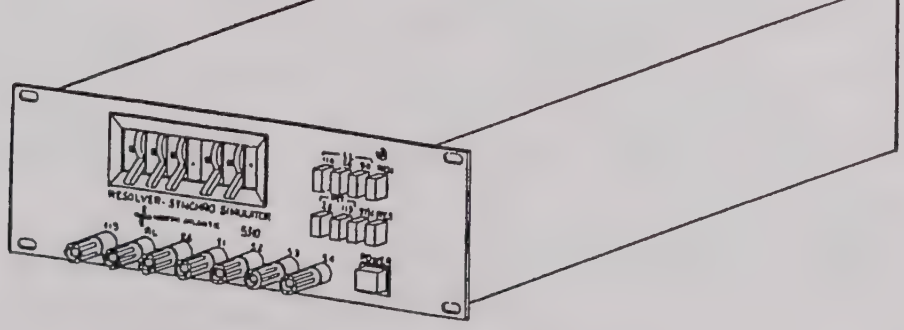


Figure 1-1. Resolver/Synchro Simulator

1-2 PHYSICAL DESCRIPTION

The Model 5310 (figure 1-1) replaces the Programmable Resolver/Synchro Simulator 538 Series. The Model 5310 is housed in a 3-1/2 x 9-1/2 x 12" enclosure and is used as a rack mounted unit or as a programmable device for ATE systems.

1-3 FUNCTIONAL DESCRIPTION

The Model 5310 is designed as a rack mounted unit to drive control type synchros and resolvers. Typical applications include production test, numerical control, and simulation systems.

The Model 5310 features fully isolated inputs and outputs and is fully protected against accidental short circuits, overloads, overvoltage, and transients on the reference input and power lines.

Standard features include full programmability for resolver/synchro selection line-to-line selection, reference levels, and synchro angles. Remote control is via parallel BCD or binary data. IEEE-488 interface is optionally available.

1-4 CONFIGURATION

The Model 5310 is comprised of the following major assemblies:

- Main Circuit Card Assembly (CCA)
- BCD/Binary converter CCA
- IEEE-488 Interface CCA (optional)

Options are specified by a two-digit number following the model number as follows:

5310-F □ □

□ — Frequency Range

1 = 360 Hz - 5 kHz
2 = 47-440 Hz

□ — IEEE-488

1 = Parallel interface without IEEE-488
2 = with NATIVE IEEE-488
3 = with MATE/CIIL interface

1-5 SPECIFICATIONS

Table 1-1 provides characteristics and specifications for the Model 5310.

Table 1-1. Specifications

Item	Specification	
Digital inputs		
Type	TTL/DTL/LSTTL compatible; 0 V=logic 0, 5 V=logic 1	
Load	All inputs are one LSTTL load	
Angle inputs	18 bit binary or BCD data, switch selectable	
Resolver/synchro select	1=synchro; 0=resolver	
Reference level input	1=26 V; 0=115 V	
Output L-L level controls	L-L 2	L-L 1
11.8 V L-L	0	1
26 V L-L	1	0
90 V L-L	1	1

Table 1-1. Specifications (Continued)

Item	Specification
Data strobe	All data and control inputs are latched on the positive going transition of the data strobe. (Minimum pulse width is 1 us.)
Reference inputs	F2=1:26 V and 115 V, 360 to 5 kHz (from rear connector and front panel binding posts) F2=2:26 V and 115 V, 47 to 440 Hz (from rear connector and from binding posts)
Front-panel inputs	Angle data and all control functions switch selectable when in local mode
Synchro outputs	
Outputs	From rear connector or front-panel binding posts
Resolution	0.00137° binary or 0.01° BCD
Accuracy	0.01° no load, 0.03° with 1.5 VA load, 0.06° with 3.0 VA load 70° inductive at 400 Hz
Scale variation	±0.1% function conformity
Programmable Angle Rate, with IEEE interface only; BCD mode only	0.1 degree/second to 999 degrees/second nominal, constant rate or triangle wave function
Power requirements	115/230 V ac, 47 to 440 Hz, 0.5 A at 115 V ac (switch selectable)
Fuse	1 A, Slo-Blo, Type 3 AG for 115 V ac operation 0.5 A, Slo-Blo, Type 3 AG for 230 V ac operation
Temperature range	0° to 50°C
Size	9.5" W x 3.47" H x 14.5" D
Weight	13.5 lbs.

1-6 ACCESSORIES

The Model 5310 can be ordered with mounting adapters for mounting either one or two units in a standard 19-inch equipment rack. Table 1-2 describes full rack and tandem full rack mounting accessories.

Table 1-2. Rack Mounting Adapter Accessories

Type of Mount	Description	NAI P/N
Full Rack Mounting	Mounts one unit in 19-inch rack	783893
Tandem Full Rack Mounting	Mounts two units side by side in 19-inch rack (3-1/2" rack height)	548557
Tandem Full Rack Mounting	Mounts two units side by side in 19-inch rack (increases rack height to 7")	787026

1-7 EQUIPMENT REVISION LEVEL STATUS

Table 1-3 lists the major assemblies of the Model 5310 and the current revision level status of each assembly. For subsequent updates to Model 5310 assemblies refer to SECTION 9 - UPDATE INFORMATION.

Table 1-3. Revision Level Status of Major Assemblies

Ref Des	Description	NAI P/N	Current Revision
A1	Chassis Assembly	783878	H
A1A1	Main Circuit Card Assembly (CCA)	783871-1	A
A1A2	Four Transistor/Spacer Assembly	783881	C
A1A3	Three Voltage Regulator/Spacer Assembly	783882	C
A1A4	Transistor Spacer Assembly	783883	D
A1A5	Two Voltage Regulator/Spacer Assembly	783884	C
A2	Front Panel/BCD Circuit Card Assembly	783879	C
A2A1	BCD/Binary Converter CCA	783870	D
A2A2	Synchro/Resolver Selection Switch Assembly	783873	B
A2A3	Line-to-Line Selection Switch Assembly	783874	B
A3	IEEE-488 Interface CCA	787467-1,-2	C

SECTION 2

INSTALLATION

2-1 INTRODUCTION

This section provides instructions for unpackaging, inspecting, installing, and checkout of the Model 5310.

2-2 UNPACKING AND INSPECTION

This instrument has been thoroughly tested, inspected, and evaluated at the factory before shipment. Care has been taken in the design of the wrapping and packaging material to insure no damage results from mishandling.

Inspect the instrument externally. Check the front panel for signs of damage to the switches. Check the switches for smooth operation. Switch buttons should be secure. Check the condition of the connector and fuse on the back panel. Check covers for damage and loose screws. If the instrument passes this inspection, install it and place it in operation. If damage is found, refer to the Warranty in the back of the manual.

2-3 INSTALLATION

2-3.1 Mounting Instructions. The Model 5310 may be mounted in a standard 19-inch equipment rack when a full rack mounting adapter is used. It requires no special cooling equipment. Mount the unit so that air flows freely around it, particularly the rear panel used to transmit the power supply heat to the ambient air. Figure 2-1 provides outline dimensions for the Model 5310 and figure 2-2 illustrates full and tandem rack mounting. A tandem full rack (two unit) adapter accessory kit is also available.

2-3.1.1 Full Rack Mounting.

a. Mount full rack extender panels to each side of unit using #10-32 x 5/8-inch pan head screws.

b. Mount unit to standard 19-inch equipment rack using four securing screws (not supplied).

2-3.1.2 Tandem Full Rack Mounting (NAI P/N 548557).

a. Referring to figure 2-2, establish left and right mounting locations for each instrument.

b. Remove top cover mounting screws from right side of Instrument A and left side of Instrument B.

c. Mount bracket (NAI P/N 299399 w/o PEM) to the right side of Instrument A using #4-40 x 3/8-inch securing screws and lock washers.

NOTE

Make certain larger clearance holes in end of bracket are toward the front.

d. Mount bracket (NAI P/N 299405 w/PEM) to the left side of Instrument B using #4-40 x 3/8-inch securing screws and lock washers.

NOTE

PEMs in bracket should be positioned towards the rear.

e. Join the two instruments together side by side so that the bracket of Instrument B slides inside of the bracket of Instrument A.

f. Secure the front panels of both instruments to the mounting brackets using four #6-32 x 7/16-inch screws and #10-32 lock nuts.

g. Secure the rear ends of the brackets together by screwing four #6-32 x 7/16-inch screws into threaded PEM holes.

h. Install the tandem mounted instruments into a standard 19-inch equipment rack using four securing screws (not supplied).

2-3.1.3 Tandem Full Rack Mounting (NAI P/N 787026)

a. Referring to figure 2-2, establish left and right mounting locations for each instrument.

b. Secure channel support bracket to the two angle support rack mounts by screwing six flat head #8-32 x 1/2-inch screws in threaded PEM holes.

c. Secure both instruments to channel support bracket by screwing four #10-32 x 1/2-inch screws in threaded PEM holes.

d. Install the tandem mounted instruments into a standard 10-inch equipment rack using twelve securing screws (not supplied).

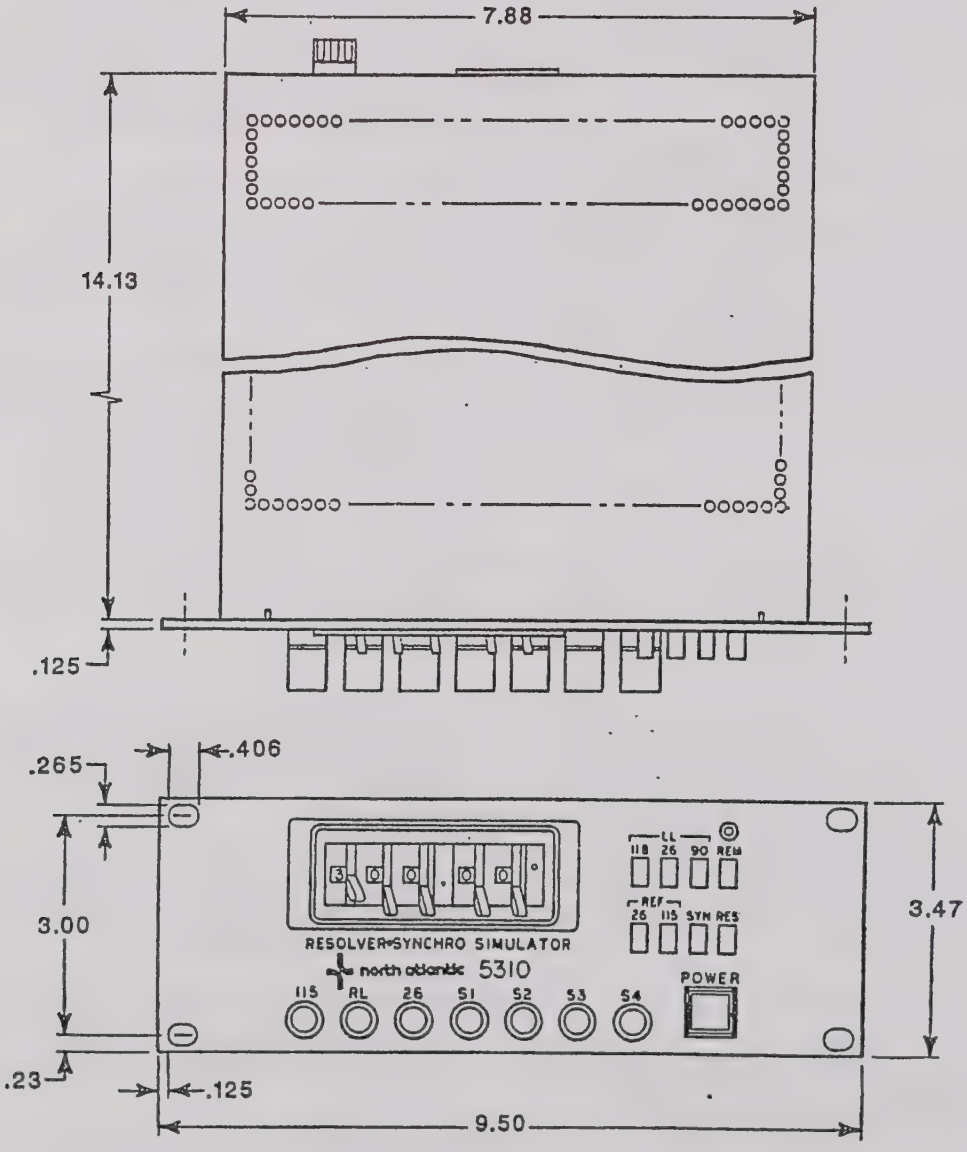


Figure 2-1. Model 5310 Outline Drawing

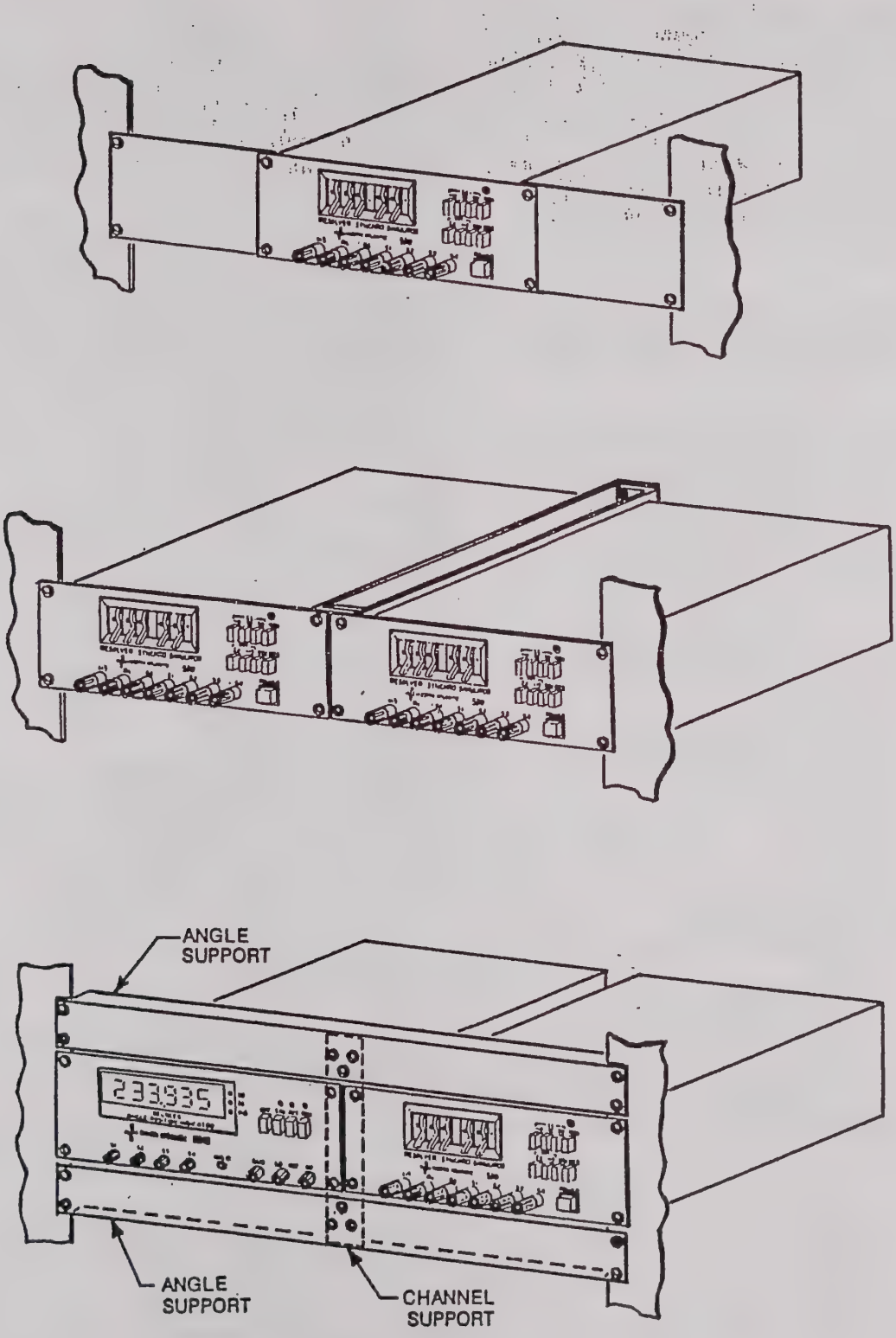


Figure 2-2. Full Rack and Tandem Rack Mounting Adapters

2-3.2 Cabling Instructions. System interconnection to the Model 5310 is through rear panel connector J1. Pin designations are given in table 2-1 and specifications are given in table 1-1.

Data lines connected per table 2-1 can be binary or BCD (selected via rear panel switch). BCD designations are enclosed in parentheses, for example (.04°), etc.

When the unit has the IEEE-488 option the I/O signals are sent via rear panel connectors J1 and J2.

Local control is selected via the front panel switches and the angle generated on the front panel connectors is dependent on the rear panel BCD switch setting.

WARNING

Front panel connectors are active at all times regardless of local, remote, or IEEE-488 selection. Turn off or remove reference input when wiring front connectors.

Model 5310 parallel I/O 50-pin mating connector J1 is supplied by North Atlantic Industries (NAI P/N 783718) but cable assembly must be made by operator. It consists of the following parts:

Description	AMP P/N	Qty
Shell	205211-1	1
Clamp	205732-1	1
Retainer	205980-1	2
Pins	66569-3	50

Table 2-1. J1 Pin Designations

Pin	Function
1	S/R Select
2*	Power input HI (115 V)
3*	Power input LO (115 V)
4	Chassis ground
5	Spare
6	Strobe
7	Spare
8	Spare
9	Digital ground
10	Spare
11	Spare
12	0.005° (0.04°)
13	0.044° (0.2°)
14	0.352° (1°)
15	2.813° (8°)
16	22.5° (40°)
17	180° (200°)
18	S2
19	S4
20	Ref LO
21	Spare
22	Spare
23	Spare
24	Spare
25	Spare

Table 2-1. J1 Pin Designations Continued

Pin	Function
26	Spare
27	Spare
28	0.0027° (0.02°)
29	0.022° (0.1°)
30	0.176° (0.8°)
31	1.406° (4°)
32	11.25° (20°)
33	90° (100°)
34	S1
35	S3
36	Spare
37	115 V ref
38	26 V ref
39	Spare
40	Ref level select
41	LL1
42	LL2
43	Spare
44	Spare
45	0.0014° (0.01°)
46	0.011° (0.08°)
47	0.088° (0.4°)
48	0.703° (2°)
49	5.625° (10°)
50	45° (80°)

*Jumpered on Main CCA. Refer to paragraph 2-3.3.

CAUTION

Before changing rear panel voltage selection switch to 230 V position, replace existing fuse with 0.5 A, Slo-Blo, Type 3 AG fuse or damage to unit may result.

2-3.3 115 V/230 V Power Selection. The Model 5310 is factory set for 115 V ac operation. The unit can operate using either 115 V ac or 230 V ac power as selected by the rear panel voltage selection switch (refer to figure 3-1). To select the 230 V ac option, proceed as follows:

1. Turn off front panel POWER switch.
2. Remove rear panel fuse holder cap and existing 1 A fuse.
3. Replace fuse with a 0.5 A, Slo Blo, Type 3 AG fuse.
4. Replace fuse holder cap and secure.
5. Place rear panel 115/230 V selection switch in the 230 V position.

2-3.4 Alternate Power Application. The Model 5310 is normally powered via the line cord. If desired, the Model 5310 can be powered via connector J1 (pins 2 and 3) on the rear of the unit after the following modifications have been made:

a. Remove black lead of line cord from fuse holder on rear panel.

b. On Main CCA, cut pad area between E42 and E41.

c. On Main CCA, install jumper between E35 and E36.

d. Connect wire between E37 on Main CCA and fuse holder.

2-4 PERFORMANCE CHECK

After installing or repairing the Model 5310, execute the performance check procedure of table 2-2.

Table 2-2. Performance Check

Step	Procedure Indication Corrective action
1.	Connect equipment as shown in figure 2-3.
2.	Set the Model 5310 front panel controls as follows: LL to 11.8 — SYN to off REM to off — RES to on REF to value applied
3.	Using lever wheel switches on the Model 5310, program the angle to 0.00°. API displays 0.000° ±0.014°. Perform troubleshooting procedure.
4.	Advance lever wheel switches in 10° increments from 0.00° to 360.00°. API displays programmed angle ±0.014°. Perform troubleshooting procedure.
5.	Program the Model 5310 for 11.8 V and SYN mode and check the angles of 0°, 45°, 90°, 135°, 180°, and 270°. API displays programmed angle ±0.014°. Perform troubleshooting procedure.
6.	Repeat step 5, in turn, for the following modes: NOTE Make sure the L-L level light on the API is correct. 26 V RES — 90 V RES 26 V SYN — 90 V SYN

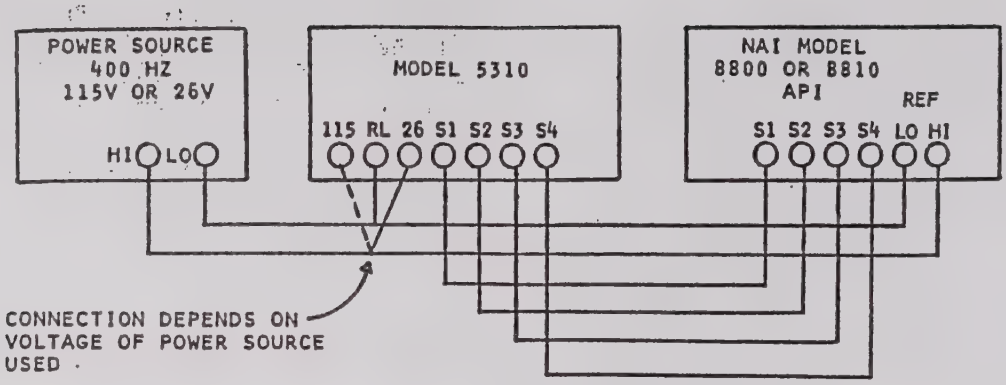
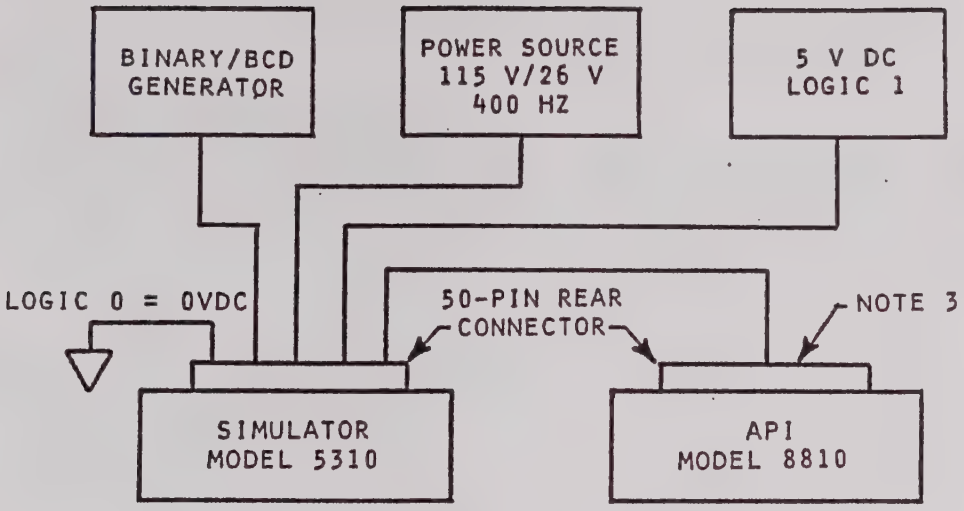


Figure 2-3. Performance Check Set-Up

Table 2-3. Performance Check
(Non-IEEE-488 Remote Operation Model 5310)

Step	Procedure Indication Corrective action
1.	Connect equipment as shown in figure 2-4. (Model 5310 should be wired as outlined in table 2-1, J1 pin designation.)
2.	Depress the REMote switch on the front panel.
3.	Set the rear input logic as follows (refer to table 2-1): LL1 = 1, LL2 = 0 for 11.8 V L-L; resolver synchro select = 0 for resolver mode; reference level = 1 for 26 V reference; strobe pulse set for 1 to 4 microseconds; angle inputs: if less than 18 bits binary or BCD data lines are used, tie all unused LSBs low. (e.g., if 14-bit input is supplied, tie bits 15 to 18 low).
4.	Program binary/BCD generator for angle of 0.00°, API indicates 0.00° $\pm$0.014°.
5.	Step binary/BCD generator for successive decades (i.e., 1°, then .1°, then .01°, between 0.00° to 9.99°. API indicates programmed angle $\pm$0.014°.
6.	Step binary BCD generator for 10° increments from 0.00° to 360.00°. API indicates programmed angle $\pm$0.014°.
7.	Program resolver/synchro select = 1 for synchro mode and check angles of 0°, 45°, 90°, 135°, 180°, 270°. API indicates programmed angle $\pm$0.014°.
8.	Repeat step 7, changing input logic for the following modes: 26 V RES, 26 V SYN, 90 V RES, and 90 V SYN. L-L level light of API responds accordingly.



NOTES:
1. REFER TO TABLE 2-1 FOR REAR CONNECTOR WIRING OF MODEL 5310.
2. API FRONT PANEL CONNECTIONS COULD BE USED AS AN ALTERNATE METHOD OF MEASURING ANGLE.
3. REFER TO 8810 MANUAL FOR CONNECTOR WIRING.

Figure 2-4. Performance Check Setup (Non-IEEE-488 Remote Operation)

SECTION 3

OPERATION

3-1 INTRODUCTION

This section provides operating instructions, descriptions of controls and indicators, and IEEE-488 and MATE/CIIL interface programming information for the Model 5310.

WARNING

A potential shock hazard exists when the unit is operated with ungrounded power source or case. Operators should take necessary precautions.

3-2 CONTROLS AND INDICATORS

The controls and indicators for the Model 5310 are described in table 3-1 and illustrated in figure 3-1.

Table 3-1. Controls and Indicators

Control or indicator	Function
POWER push button	Turns power on and off.
REM push button	Allows remote operation of the unit.
RES push button	Selects resolver mode of operation.
SYN push button	Selects synchro mode of operation.
LL 90, 26, 11.8 push buttons	Selects 90 V, 26 V, or 11.8 V line-to-line levels in either synchro or resolver mode.
REF 26, 115 push buttons	Selects 26 V or 115 V reference input voltage.
Angle Selection switch	Programs the converter to the output angle displayed.
115/230 LINE PWR switch*	Permits selection of 115 V or 230 V ac operation.
BCD/BIN INPUT DATA switch*	Allows unit to interpret, through J1 or the optional IEEE-488 interface J2 as BCD coded data or binary angle data.
CHAS/FLOAT CKT GND switch*	In CHAS position, ties circuit ground to the chassis. In the FLOAT position, circuit ground is floating.
1 A, Slo-Blo fuse*	1 A, Slo-Blo, Type 3 AG for 115 V ac operation
0.5 A, Slo blo fuse*	0.5 A, Slo-Blo, Type 3 AG for 230 V ac operation
S1,S2,S3,S4 terminals	Synchro or resolver outputs.
26 terminal	26 V reference input.
RL	Reference ground.
115 terminal	115 V reference input.

*Located on rear panel.

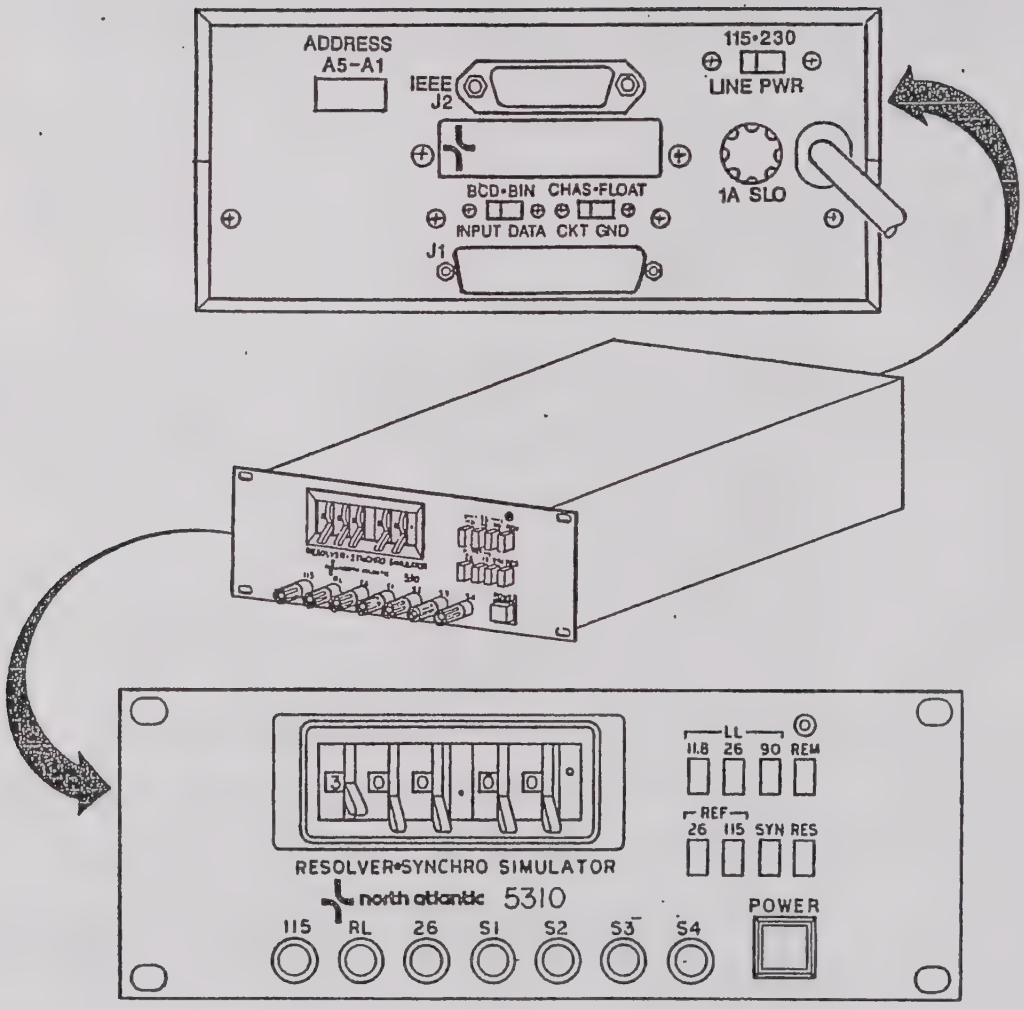


Figure 3-1. Controls and Indicators

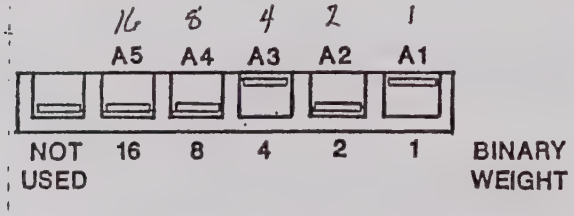
3-3 IEEE-488 OPTION

The following paragraphs describe the function of the IEEE-488-1978 Standard Digital Interface for Programmable Instrumentation and the device dependent programming instructions as they apply to the Model 5310. Table 3-2 lists the interface function capabilities.

Table 3-2. IEEE-488 Interface Function Capabilities

Code	Function
AH1	Acceptor Handshake capability
SHØ	No source Handshake capability
TØ	No Talk capability
L1	Listen capability
SRØ	No Service Request capability
RL1	Remote-Local capability
PPØ	No Parallel Poll capability
DC1	Device Clear capability
DT1	Device Trigger capability

3-3.1 Address Selection. The listen address of the Model 5310 is programmed by the ADDRESS DIP switches A1 through A5 accessible from the back panel. The address is binary coded. For example, to use address #5 push A1 and A3 up (see sketch below).



3-3.2 Message Data Format. The following paragraphs provide message data format information.

a. Messages are assumed complete and terminated only when Carriage Return and/or Line Feed are received.

b. Data characters (ASCII Hex, 0-9, A-F) are stored sequentially as shown in table 3-3. The user has the option of sending just data characters (first character stored in position 1) or of using one or more positioning characters followed by data characters.

c. The Group command can be located anywhere in a message.

d. Where data position uses less than 4 bits, the unused bits of the data character are ignored.

Table 3-3. Programming Chart

Function	Position command character	Pos. No.	Data character (Binary Bits)	Data character (BCD)
Input Angle	I	1	1-2	100s
	N	2	3-6	10s
	P	3	7-10	1s
	U	4	11-14	.1s
	T	5	15-18	.01s
Mode	M	6	Resolver = 0	
			Synchro = 1	
Reference input level	R	7	115 V = 0	
			26 V = 1	
Output L-L voltage	V	8	11.8 V = 1	
			26 V = 2	
			90 V = 3	
Group command (inhibit execution until GET)	G			
Message terminator	Line Feed or Carriage Return			

Table 3-3. Programming Chart (Continued)

Function	Position command character	Pos. No.	Data character
Sets tracking rate angle	S		<rate>
Set end angle delimiter	E		<angle>

3-3.3 Programming. The following steps provide IEEE-488 programming information.

a. After addressing, the Model 5310 is ready to receive bits 1-2. Data can be sent without a position command character if data if presented in the correct order.

b. Binary data is entered as the hex equivalent of each 4 bits of the binary angle. Bit 1 = 180°, bit 2 = 90°, etc. Examples:

To program 270.00°, send 30000 in ASCII

To program 22.5°, send 04000 in ASCII

c. BCD data is entered directly starting with the 100's (position no. 1), 10's (position no. 2), etc. Examples:

To program 270.00°, send 27000 in ASCII

To program 22.5°, send 02250 in ASCII

d. After the 5 bytes of angle data are sent, the Model 5310 is ready to receive mode programming, reference input level programming, and output L-L programming as shown below.

Binary	BCD
30000111	27000111

This programs the Model 5310 for 270° synchro, 26 V REF, 11.8 V L-L.

e. If only one portion of the data is to be changed, it can be accessed by the appropriate position command character.

Sending the character M, positions the Model 5310 to receive mode programming data. After the mode programming character is received, the Model 5310 is positioned to receive REF level programming.

In summary, the data receiving sequence can be entered at any point by sending the appropriate position command character.

f. Line Feed and/or Carriage Return must be used to terminate each message received by the IEEE-488 interface.

g. Sending the character G, indicates to the Model 5310 to wait for a GET command before executing data.

h. Upon power-on, Device Clear and Selected Device Clear, the unit will be in the following state:

Resolver, 115 V REF, 11.8 V L-L, angle set to 0°.

3-4 RATE AND TRIANGULAR WAVE MODES

NOTE

Rate and Triangular wave modes are only available when in BCD mode.

The Model 5310 is capable of generating angular rates of .1 d/s to 999.9 d/s. When programmed, the output of the unit is updated every 6 milliseconds by delta. Delta is computed as follows:

delta = programmed rate x (.006)

NOTE

If delta is less than 0.01°, the resolution of the Model 5310, then updates may not occur at every 6 ms interval. The updates will be stored and the update will occur when the sum of these small deltas exceeds 0.01°.

The triangular wave mode operates in the same manner as the rate mode except when the end angle is reached. At that point the sign of the delta is changed and the angle runs in the opposite direction until the start angle is reached. The sign of delta is changed again and then the process continues until the rate is programmed to zero or a device clear is received.

3-4.1 Rate Programming. To program a rate, the following syntax is appended to the basic angular programming string:

S sXXX.X

where XXX.X is the rate in deg/sec and s is the sign (+ or -, omitted = +).

Positive rates result in an increasing angle (counterclockwise rotation) and negative rates result in a decreasing angle (clockwise rotation). The starting angle is programmed with the normal angle programming command.

3-4.2 Triangular Wave Programming. The triangular wave mode allows the unit to run at a rate between two angles. The syntax for this mode is:

S sXXX.X E xxxxx

where XXX.X is the rate in deg/sec, s is the sign (+ or -, omitted = +), and xxxxx is the end angle in the same format as standard angle programming.

The waveform will start at the normal programmed angle and run until it reaches the end angle and then reverse directions. It will continue this sequence until the rate is programmed to zero (send S 0.0) or a DCL is received.

3-4.2.1 Examples.

a. To program a rate of 100 deg/sec starting at 45 degrees use the following:

04500011 S 100.0<cr><lf>

b. To program a rate of -500 deg/sec starting at 0 degrees use the following:

00000011 S -500.0<cr><lf>

c. To program a triangular wave running at a rate of 10 deg/sec between 300 degrees and 270 degrees use the following:

30000011 S 10.0 E 27000<cr><lf>

3-5 MATE/CIIL PROGRAMMING

3-5.1 Introduction. This section describes the operation and programming of the Model 5310 using the MATE/CIIL language option. Recommended reference documents are:

a. MATE Control Interface Intermediate Language - Standard 2806763 Rev C

b. MOD 1 - MATE User's Group Action Traveler - CIIL Definitions

The following notation shall be used to describe various input and output strings:

¦	:- exclusive OR
<>	:- the boundaries of a field or structure of inseparable items.
<b>	:- one ASCII blank
[ ]	:- an optional field, item, or structure.
...	:- the field or structure may be repeated as often as required.
<setcode>	:- SET ¦ SRX ¦ SRN
<noun>	:- SYN or RSL
<modifier>	:- four ASCII encoded characters. See table 3-4 for a complete list

<chan num> :- 1 or 2 digit number indicating the channel number.

value] :- any ASCII encoded number in floating point, engineering, or integer notation.

<cr,lf> :- ASCII encoded carriage return followed by line feed.

3-5.2 IEEE-488 Interface Subsets.

The following are the IEEE-488 interface subsets:

SH1, AH1, T8, TE0, L4, LE0, SR0, RL1, PP0, DC1, DT1

3-5.3 IEEE-488 Bus Commands. The following IEEE-488 bus commands are implemented:

a. IFC (Interface Clear) - The IFC command will clear the Model 5310 IEEE-488 interface.

b. DCL (Device Clear) - The DCL command resets the Model 5310 to a power-up condition.

3-5.4 Inputs. There are seven transmission types of inputs applicable to the Model 5310 in the CIIL language. At the start of each type the instrument will be "listen addressed" by the control computer. The end of the transmission will be indicated by <cr,lf>. Each transmission type begins with its own characteristic <verb>. They are as follows:

FNC Setup the instrument
CLS Close the output path
OPN Open the output path
RST Reset the instrument
STA Report status
IST Initiate built-in-test
CNF Initiate confidence test

As a general rule, anywhere one <b> (blank) is indicated, the Model 5310 will accept multiple blanks as if they were one blank.

3-5.4.1 Format of FNC. The FNC string is used to set up the instrument. The general format of the FNC string is:

FNC<b><noun><b>:CH<chan num>

[<b><setcode><b><modifier><b>[value]] ...<cr,lf>

where:

<noun> defines the type of signal to be generated:

SYN - selects synchro
RSL - selects resolver

If any other <noun> appears an error message will be generated.

<chan num> specifies the input channel. The <chan num> must be specified as 0 or 00.

<set code> is defined as the ASCII sequences of SRX, SET, or SRN. If the same <modifier> appears more than once with a different <set code>, the Model 5310 will use the one with the highest priority. The order of priority is:

1. SET 2. SRN 3. SRX

<modifier> Modifiers program features of the Model 5310. Modifiers are checked to verify that they are within the capabilities of the unit. The modifiers recognized by the Model 5310 are:

Modifier	Description
ANGL	angle
ANRT	angle rate
REFV	reference voltage
VOLT	output L-L voltage
FREQ	frequency

If any other modifiers appear an error message will be generated.

[value] is an ASCII encoded number in floating point, engineering, or integer notation. The value following all <modifier> fields is checked to insure that it is within the limits given as follows:

47	≤	FREQ	<	5001
0	≤	ANGLE-RATE	<	1000
0	≤	ANGLE	<	360

The following <modifiers> will only accept the <values> listed below:

REFV	26 or 115
VOLT	11.8, 26, 90

3-5.4.2 Format of CLS. The format of the CLS message can be either of the following:

CLS<b>:CH0<cr,lf> or CLS<b>:CH00<cr,lf>

3-5.4.3 Format of OPN. The format of the OPN string can be either of the following:

OPN<b>:CH0<cr,lf> or OPN<b>:CH00<cr,lf>

The OPN command sets the output voltage to zero.

3-5.4.4 Format of RST. The RST command causes the Model 5310 to reset the current measurement. The format of RST is:

RST<b><noun><b>:CH<chan num><cr,lf>

The <noun> must match the <noun> in the previous FNC message or this command will be ignored.

The RST command also resets the unit to its initial power-up state.

3-5.4.5 Format of STA. The STA command instructs the Model 5310 to return the status of the instrument. The format of this command is:

STA<cr,lf>

3-5.4.6 Format of IST. The IST command instructs the Model 5310 to perform an internal self-test procedure. This consists of a brief one second test of the IEEE-488 interface circuit card only. After the test is completed the result can be obtained using the STA command. No messages are allowed to be sent to the Model 5310 while the test is in progress or an error message will be generated. The format of the IST is:

IST<cr,lf>

3-5.4.7 Format of CNF. The CNF command instructs the Model 5310 to perform a confidence test. In the Model 5310 this test is identical to the IST test. The format of the CNF is:

CNF<cr,lf>

3-5.5 Outputs.

3-5.5.1 Response to STA. The response to STA will be either:

<b><cr,lf> or an error message

STA is typically used after the unit is setup to determine if it was programmed properly, and also after a CNF or IST. The <b><cr,lf> message indicates no errors were found.

3-5.5.2 Errors. Error messages are generated for the following basic reasons:

a. Syntax errors
b. Values out of range
c. Failure of CNF or IST

Once an error is loaded into the output buffer it will remain there until it is read by the control computer, or an RST or IEEE-488 DCL command is issued. Error messages have the following form:

F07SRS00 (MOD): <ASCII message><cr,lf>

See table 3-5 for a complete list of error messages.

Table 3-4. CIIL Codes

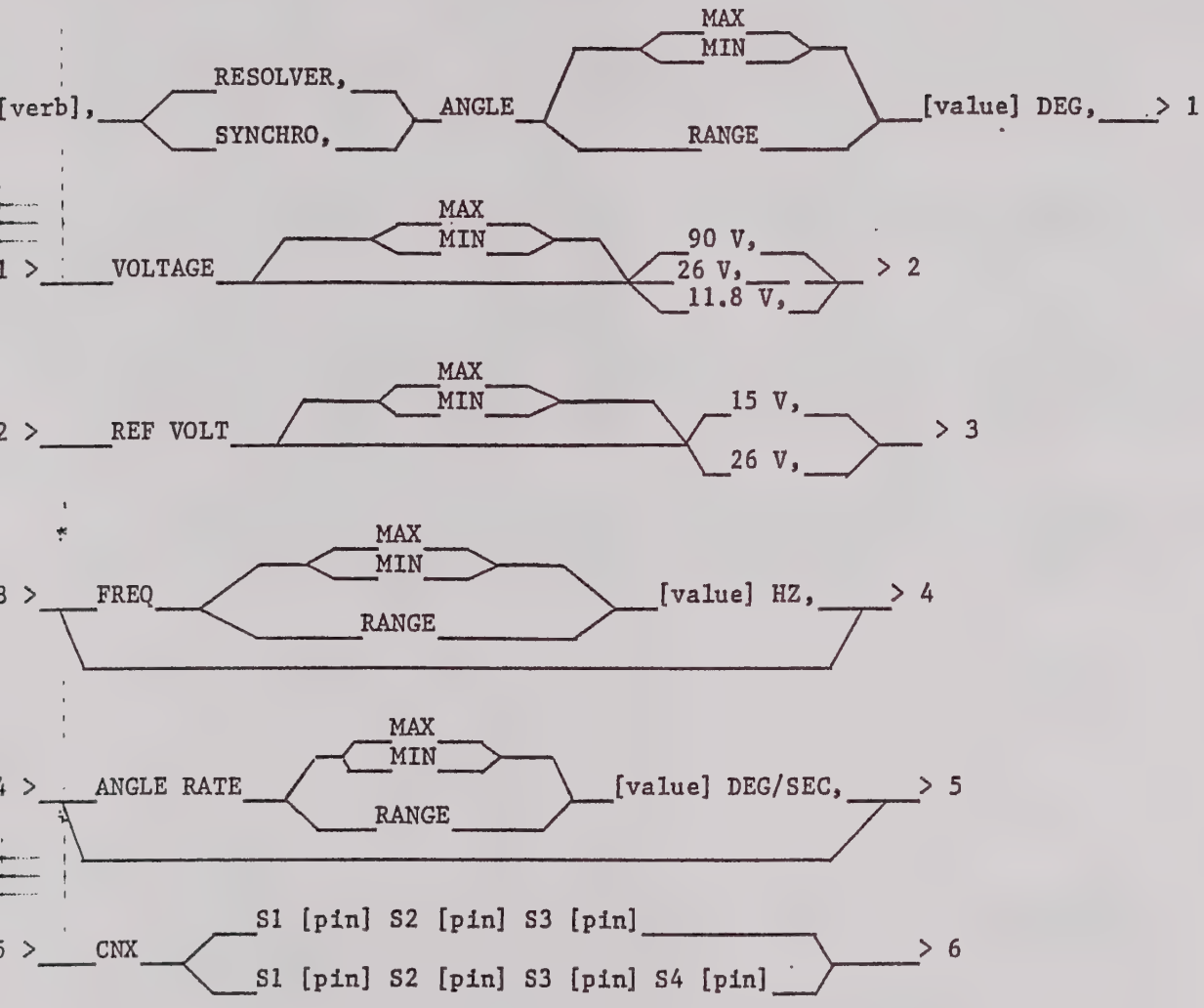
CIIL	Description
<verbs>:	
FNC	function
OPN	open
CLS	close
STA	status
RST	reset
CNF	confidence test
IST	BIT test
<setcodes>:	
SET	set
SRX	set maximum
SRN	set minimum
<nouns>:	
SYN	synchro
RSL	resolver
<modifiers>:	
ANGL	angle
ANRT	angle rate
REFV	reference voltage
VOLT	voltage
FREQ	frequency

Table 3-5. Error Messages

```
F07SRS00 (MOD): ILLEGAL NOUN
F07SRS00 (MOD): ILLEGAL CHANNEL NUMBER
F07SRS00 (MOD): SYNTAX ERROR
F07SRS00 (MOD): SET PROG ERROR
F07SRS00 (MOD): BAD MODIFIER
F07SRS00 (MOD): RATE SETUP ERROR
F07SRS00 (MOD): ANGLE SETUP ERROR
F07SRS00 (MOD): ILLEGAL VERB
F07SRS00 (MOD): STATUS STRING ERROR
F07SRS00 (MOD): VOLTAGE SETUP ERROR
F07SRS00 (MOD): REFERENCE-VOLTAGE SETUP
                ERROR
F07SRS00 (MOD): FREQUENCY SETUP ERROR
F07SRS00 (MOD): <CNF> STRING SYNTAX
                ERROR
F07SRS00 (MOD): COMMUNICATIONS DURING
                INTERNAL TESTING
F07SRS00 (MOD): INTERNAL CONFIDENCE TEST
                FAILURE
F07SRS00 (MOD): <IST> STRING SYNTAX
                ERROR
F07SRS00 (MOD): SIM NOT IN REMOTE MODE
```

3-6 ATLAS CONSTRUCTIONS

The following are typical ATLAS program syntax constructions for programming the Model 5310 SIM with the IEEE-488 interface.



NOTES:

1. The following range of [value] are allowed.

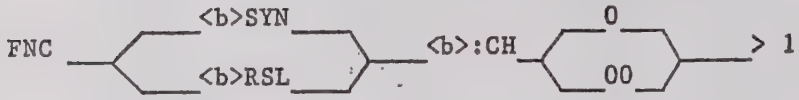
<modifier>	min	max	only
FREQ	47	<5001	
REF-VOLT			115, 26
VOLTAGE			90, 26, 11.8
ANGLE	0	<360	
ANGLE-RATE	0	<1000	

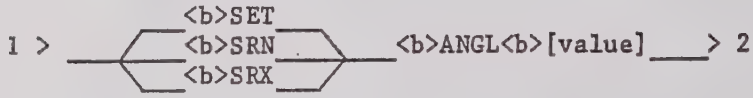
2. The output angle when angle rate is programmed is updated every 6 ms.

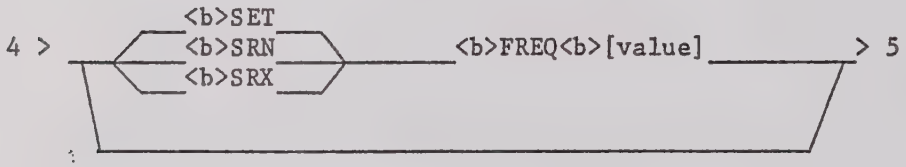
3. The polarity of the angle rate [value] determines the direction of rotation. Positive [value] results in increasing angles (counterclockwise rotation) while a negative [value] results in decreasing angles (clockwise rotation).

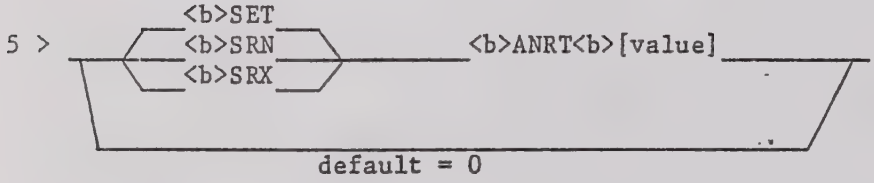
3-7 MODEL 5310 CIIL RAILROAD DIAGRAMS

The following are typical CIIL Railroad Diagrams which are used for programming the MATE/CIIL Model 5310 SIM.









SECTION 4

THEORY OF OPERATION

-1 INTRODUCTION

his section provides theory of operation or the Model 5310.

-2 SYNCHRO AND RESOLVER CONVENTIONS

onventions for polarities, terminal esignation and direction of shaft rotation or synchros and resolvers are most requently defined in accordance with ilitary specifications MIL-S-20708 synchros) and MIL-R-2153 (resolvers). The nit is provided with terminal designations nd electrical characteristics to these pecifications. In applying the onventions, exercise caution that:

a. The manufacturer of the synchro or resolver has followed the MIL specification.

b. The system use has not dictated a change in convention for a different characteristic (i.e., direction reversal or angular offset).

4-2.1 Synchro Transmitter Conventions.

$$E(S1-S3) = -NE(R1-R2)\sin\theta$$
$$E(S3-S2) = -NE(R1-R2)\sin(\theta+120^\circ)$$
$$E(S2-S1) = -NE(R1-R2)\sin(\theta+240^\circ)$$

Where E(S1-S3) is the stator voltage S1 with respect to S3. Other stator and rotor voltages are similarly defined. N is the ratio of the maximum voltage across a pair of stator terminals to the voltage across the rotor terminals. θ is the shaft angle displacement from electrical zero which satisfied these equations. A schematic of the synchro transmitter is shown in figure 4-1.

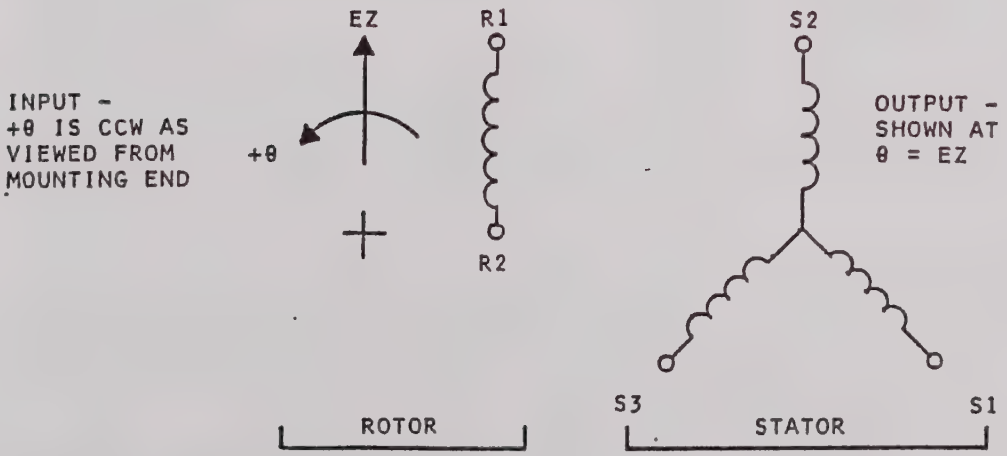


Figure 4-1. Synchro Transmitter, Schematic

4-2.2 Resolver Transmitter Conventions. For rotor energized resolvers:

$E(S1-S3) = -NE(R1-R3)\cos\theta - NE(R2-R4)\sin\theta$
$E(S2-S4) = -NE(R2-R4)\cos\theta - NE(R1-R3)\sin\theta$

A rotor energized resolver transmitter schematic is shown in figure 4-2. Input and output may be reversed for stator energized devices.

Since the NAI standard assumes an R2R4 energized resolver, the resolver outputs become:

$E(S1-S3) = -NE(R2-R4)\sin\theta$
$E(S2-S4) = +NE(R2-R4)\cos\theta$

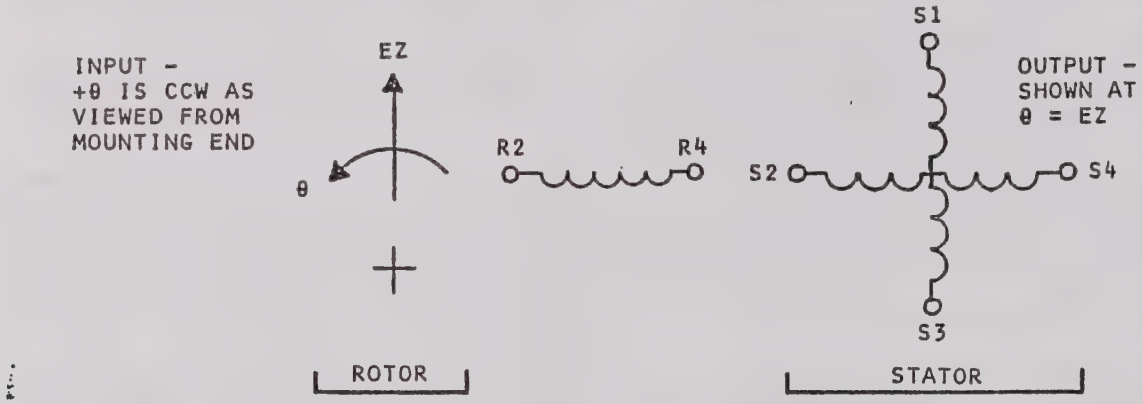


Figure 4-2. Resolver Transmitter, Schematic

4-3 BLOCK DIAGRAM DESCRIPTION (Figure 4-3)

The analog conversion section of the Model 5310 converts the 18 bits of binary angle data to ac sine/cosine data through the use of several unique precision circuits.

The ac reference signal is isolated and scaled to approximately 4.5 V by T1. U8, U9 and several resistors prescale the reference signal as a function of the 3rd through 6th bits.

The 7th through 18th bits connect to D/A converter U10 (AD7541) located in the fine bridge section. This is a differential angle converter configuration, resulting in an output angle of a+b, where, in this case, a = input angle (7th through 18th bits) and b = 42.1875°. Thus the angle represented by the outputs (s) and (c) is an angle between 42.1875° and 47.8125°, depending upon the magnitude of angle a.

Coarse interpolation bridges I and II are also differential angle conversion circuits. Both offset the incoming analog angle data by a given amount, and also advance the angle as a function of the respective digital input data.

Coarse Bridge I offsets the incoming analog data (s) and (c) by -33.75° and advances the angle by the respective weights of the 45° and 22.5° (3rd and 4th) bits.

Coarse Bridge II offsets the data from Coarse Bridge I by -8.4375° and advances the angle by the respective weights of the 11.25° and 5.625° (5th and 6th) bits.

Four quadrant operation is provided by the Quadrant Selection circuits which respond to the 180° and 90° (1st and 2nd) bits.

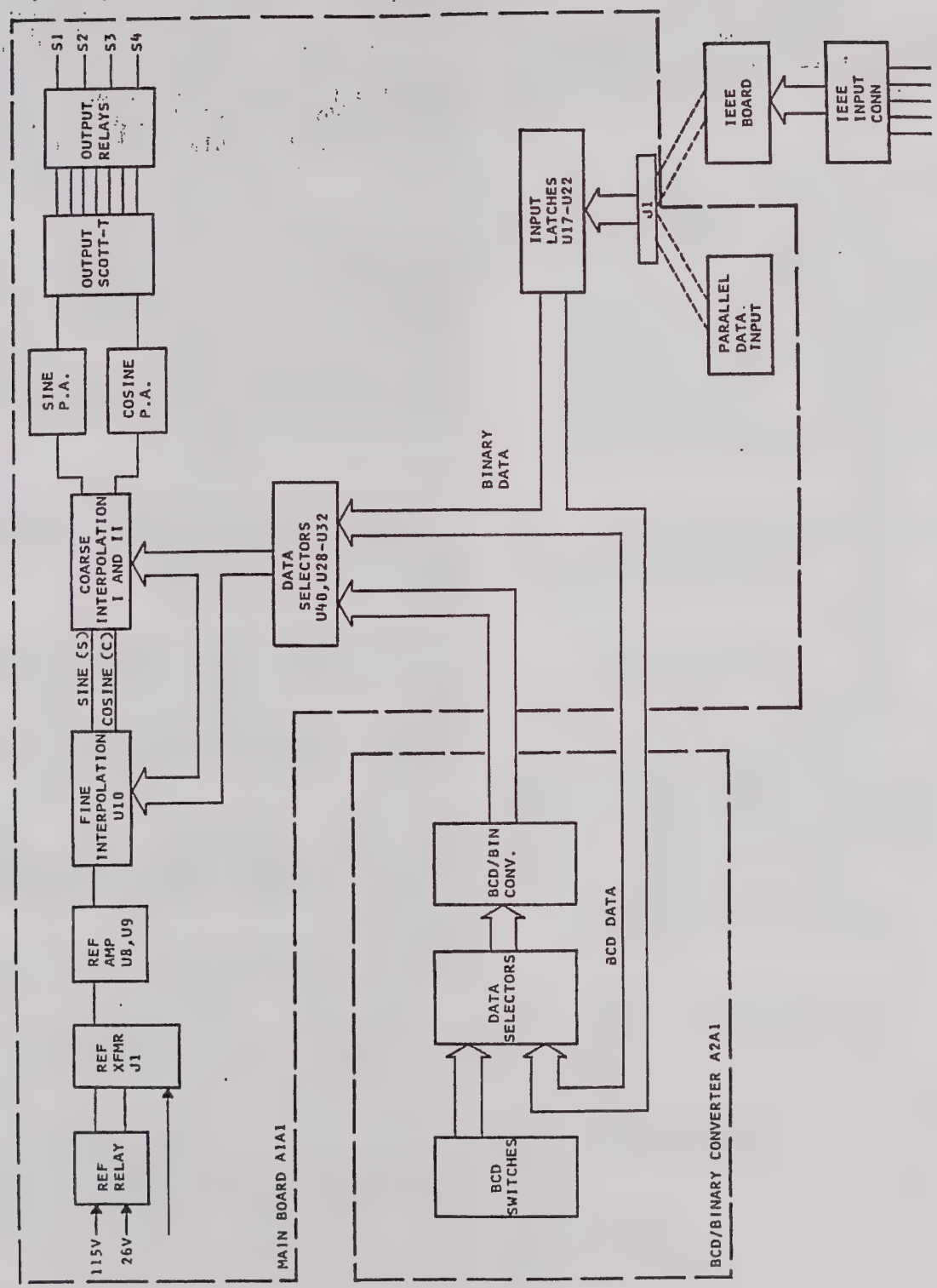


Figure 4-3. Model 5310, Block Diagram

The outputs of the Quadrant Selection circuits represent the pre-scaled ac reference signal multiplied by the Sine and Cosine of the 18-bit binary angle input. These signals connect to the output power amplifier and Scott-T transformer output circuits.

Table 4-1 provides a binary angle weight table.

Table 4-1. Binary Angle Weight Table

Bit		Weight	Circuit Section
MSB	1	180.00000	Octant
	2	90.00000	
	3	45.00000	Coarse Bridge I
	4	22.50000	
	5	11.25000	Coarse Bridge II
	6	5.625000	
	7	2.81250	Fine Bridge (a)
	8	1.40625	
	9	.70313	
	10	.35163	
	11	.17581	
	12	.08799	
	13	.04395	
	14	.02197	
	15	.01099	
	16	.00549	
	17	.00275	
LSB	18	.00137	

4-3.1 Digital Input Circuitry. U17 through U22 are the input latches. Data is transferred to the output of these latches with a positive transition of a strobe signal applied to the data strobe line (Pin 6, J1).

The data is then fed to data selectors U40 and U28 through U32 and to the BCD/Binary Converter. If the data is in BCD format it will be converted by the BCD/Binary Converter to a binary angle and the data selectors will select the data from the BCD/Binary Converter. The unit interprets data as BCD or binary based on the setting of the BCD/BIN DATA switch on the rear panel.

4-3.2 BCD/Binary Converter.

The BCD/Binary Converter converts BCD data to binary data from the front panel BCD switches or from the rear connector, depending upon the REM switch position. The appropriate data is selected by data selectors U1 through U5 for processing by the conversion circuits.

Data is split into two words: 200 - 2° and 1 - .01°. These words serve as addresses for EPROMS programmed with the binary equivalent of each word.

The two binary words are then added to obtain the correct conversion and outputted to the data selectors. The maximum conversion round-off error is .0014°.

4-3.3 Power Supply. The power supply provides ±5, +12, and +24 V. All except the 24 V supply are three terminal regulators.

SECTION 5

MAINTENANCE

5-1 INTRODUCTION

This section contains cleaning, lubrication, adjustment, and removal and replacement procedures for the Model 5310.

5-2 CLEANING AND LUBRICATION

This unit does not require lubrication. No special cleaning procedures or fluids are required. Apply good housekeeping rules to maintain the instrument free of dust and dirt.

5-3 REMOVAL AND REPLACEMENT

CAUTION

Before disassembly, turn power off and remove line cord from the unit.

NOTE

The key numbers in parenthesis refer to figure 5-1.

5-3.1 Removal of Top and Bottom Covers. Remove the top (1) and bottom (17) covers as follows:

a. Unscrew six screws (2), three on each side of the chassis (13) and lift off top cover (1).

b. Replace the top cover by reversing the removal procedure.

c. Unscrew six screws (15), three on each side of the chassis (13).

d. Turn unit on its side and remove bottom cover (16).

e. Replace bottom cover by reversing the removal procedure.

5-3.2 Removal of Front Panel (20) and BCD/Binary CCA (24). The front panel and BCD/Binary CCA are removed as a single assembly, as follows:

a. Disconnect connector A from the Main circuit card assembly (28).

b. Remove three screws (14) from each side of the chassis, securing the mounting brackets (19, 22).

c. Slide the assembly out.

d. To replace the assembly, reverse the removal procedure.

5-3.2.1 Removal of BCD/Binary CCA. To remove the BCD/Binary CCA from the front panel proceed as follows:

a. Remove four nuts (17) securing the two 4-bank switches (19, 22).

b. Remove four nuts (25) from the BCD switch assembly (23).

c. Remove the front panel (20) from the BCD/Binary CCA. The two 4-bank switches may be removed by disconnecting the pins.

d. To reassemble the front panel, reverse the disassembly procedure.

5-3.3 Removal of IEEE-488 CCA*. Remove the IEEE-488 CCA (5) as follows:

a. Unscrew two screws (6) from the rear panel and two screws (14) securing the circuit card to the mounting brackets.

*Optional unit

b. Lift card carefully and disconnect connector B from Main CCA (28).

c. Remove the IEEE-488 CCA.

d. To replace the IEEE-488 CCA, reverse the removal procedure.

5-3.4 Removal of Scott-T Transformer A1T3. Remove the Scott-T transformer (26) as follows:

a. Remove IEEE-488 CCA (if applicable) per paragraph 5-3.3.

b. Disconnect connector (C) and wires (D) from Main CCA. Tag all wires.

c. Unscrew four screws (12) securing the Scott-T transformer (26) to the side of the chassis (13).

d. Remove the Scott-T transformer.

e. To replace the Scott-T transformer, reverse the removal procedure.

5-3.5 Removal of Power Transformer A1T2. Remove the transformer (3) as follows:

a. Remove the IEEE-488 CCA (if applicable) per paragraph 5-3.3.

b. Remove wires from Main CCA. Tag wires.

c. Unscrew four screws (29) and nuts (4), securing the transformer (3) to the side of the chassis.

d. Remove power transformer.

e. Replace the transformer by reversing the removal procedure.

5-3.6 Replacement of Fuse. The power line fuse is located on the right side of the rear panel. To replace fuse, turn off power to unit and then remove fuse holder cap and existing fuse. For 115 V ac line operation use 1 A, Slo-Blo, Type 3 AG fuse; for 230 V ac operation use 0.5 A, Slo-Blo, Type 3 AG fuse. Change rear panel 115/230 V voltage selection switch accordingly.

5-3.7 Component Replacement.

CAUTION

The Model 5310 contains many CMOS integrated circuits. Handle these ICs using standard CMOS handling procedures.

The following are matched components in the Model 5310. When one of these components is changed, the whole set must be changed.

Matched components	Part No.
U10, RT1, RT2	500960
C1, C2	808874
C3, C4	808874
C5, C6	808874
C7, C8	808874

5-4 ALIGNMENT PROCEDURE

The only alignment required in the Model 5310, is the offset adjustment for the output amplifiers. Proceed as follows:

a. Remove Scott-T transformer A1T3 (paragraph 5-3.4).

NOTE

The following procedure is performed on the Main CCA.

b. Install jumpers between E27 and TP13 and between E28 and TP14.

c. Short TP10 to ground.

d. Connect DVM to TP13 and adjust R30 for a DVM reading below 0.1 mV (adjust as close as possible to 0 V dc).

e. Remove short from TP10 to ground and apply short from TP11 to ground.

f. Connect DVM to TP14 and adjust R31 for a DVM reading below 0.1 mV (adjust as close as possible to 0 V dc).

g. Remove jumpers from step b and short from step e and reinstall Scott-T transformer A1T3.

LEGEND

1 - TOP COVER MP1
3 - POWER TRANSFORMER A1T2
5 - IEEE-488 CCA A3
7 - LINE CORD A1W1
8 - FUSE HOLDER (FUSE A1F1)
9 - SWITCH A1S2
10 - SWITCH A1S3
11 - SWITCH A1S4
13 - CHASSIS ASSEMBLY A1
16 - BOTTOM COVER MP2
18 - L-L SELECTION SWITCH ASSY A2A3S1
19 - MOUNTING BRACKET (RT SIDE)
20 - FRONT PANEL ASSEMBLY A2
21 - SYN/RES SWITCH ASSY A2A2S1
22 - MOUNTING BRACKET (LT SIDE)
23 - BCD SWITCH ASSEMBLY
24 - BCD/BINARY CONVERTER CCA A2A1
26 - SCOTT-T TRANSFORMER A1T3
27 - CCA MOUNTING BRACKET
28 - MAIN CCA A1A1

CABLE LEGEND

A - BCD/BINARY CCA TO MAIN CCA TO IEEE-488 CCA
B - IEEE-488 CCA TO MAIN CCA
C - SCOTT-T TRANSFORMER TO MAIN CCA (CABLE)
D - SCOTT-T TRANSFORMER WIRES TO MAIN CCA
E - MAIN CCA TO IEEE-488 CCA

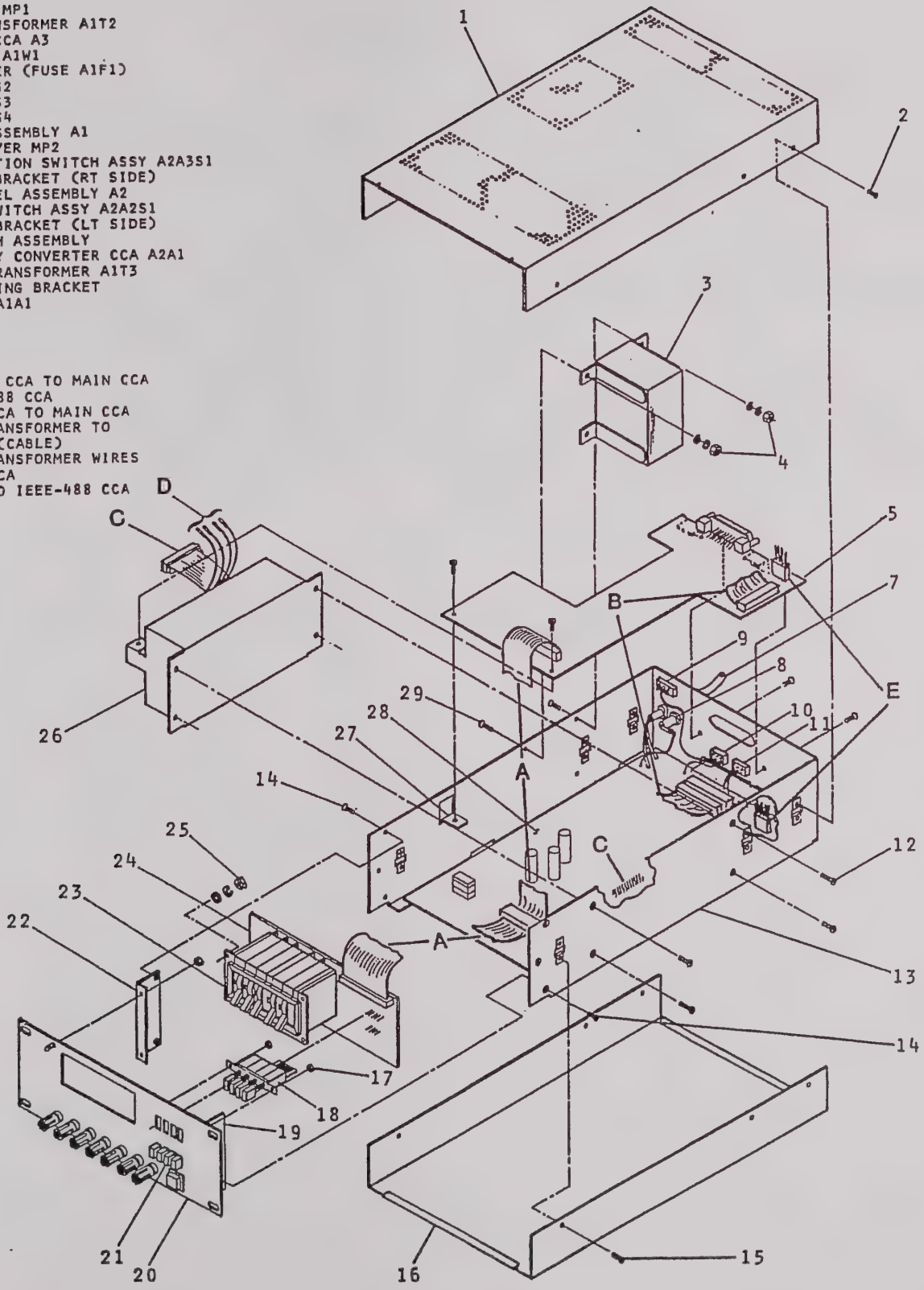


Figure 5-1. Model 5310, Exploded View

SECTION 6

TROUBLESHOOTING

6-1 INTRODUCTION

This section contains troubleshooting procedures for the Model 5310.

CAUTION

During troubleshooting, it will become necessary to remove a component (DIP) from its socket or a cable assembly from its connector. To minimize the possibility of damage, an extraction tool should be used. For dual-in-line (DIP) IC packages, and cable assemblies, Augat tool No. T114-1 is recommended.

6-2 VISUAL INSPECTION

After removing the top and bottom covers, the unit should be thoroughly inspected. Some obvious causes of trouble could be:

- Cable connectors not properly seated
- ICs not properly seated in their sockets
- Broken wires or loose components
- Burnt components indicating thermal overload. The cause should be located and corrected.
- Metallic particles shorting adjacent lands on PC boards. Both sides of boards should be inspected (where convenient) and all exposed boards completely brush cleaned to remove dust particles.

6-3 TROUBLESHOOTING.

Figures 6-1 and 6-2 provide troubleshooting procedures for the Model 5310.

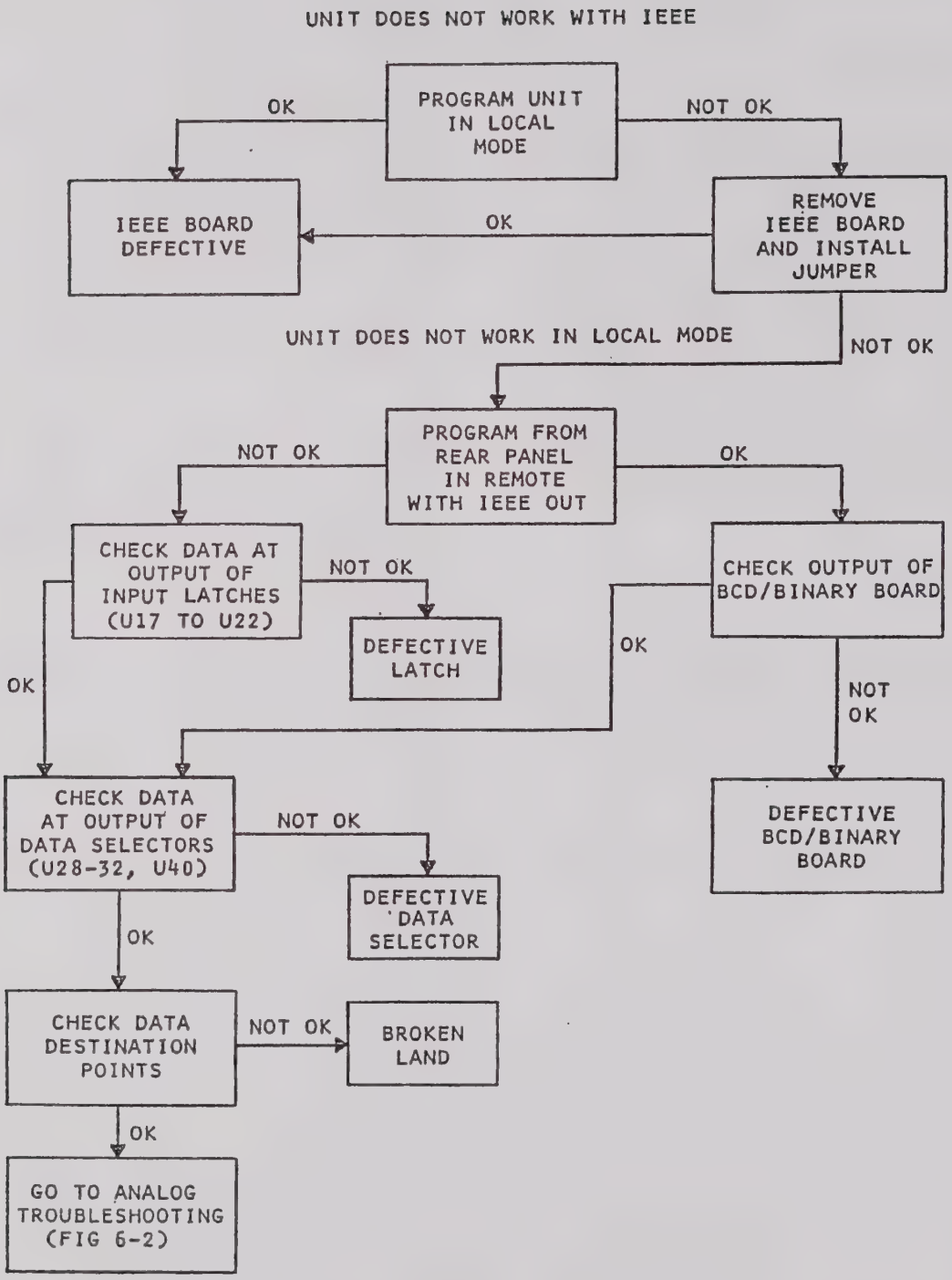


Figure 6-1. Digital Troubleshooting Chart

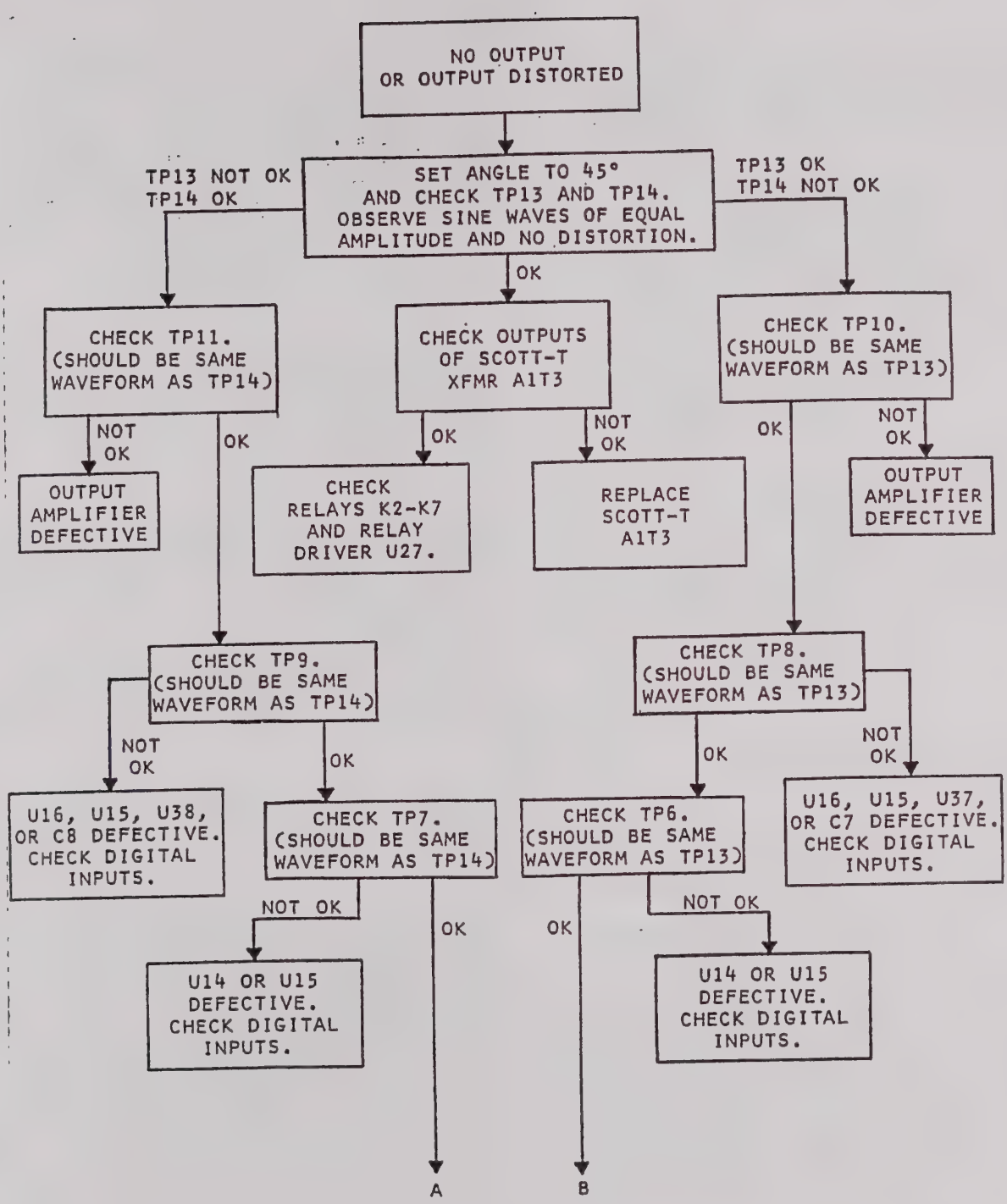


Figure 6-2. Analog Troubleshooting Chart (Sheet 1 of 2)

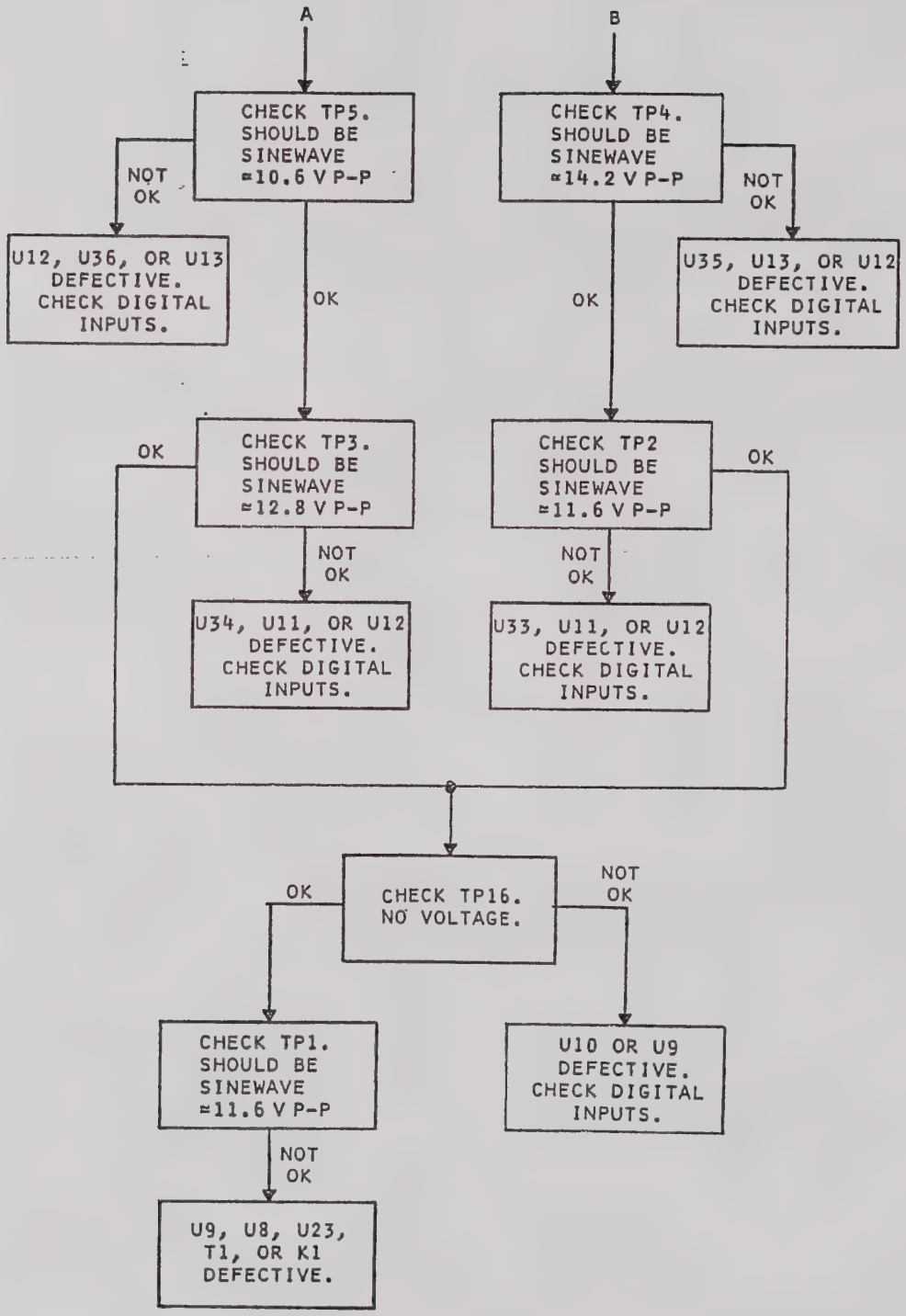

A
B
CHECK TP5. SHOULD BE SINEWAVE ≈10.6 V P-P
NOT OK
U12, U36, OR U13 DEFECTIVE. CHECK DIGITAL INPUTS.
OK
CHECK TP4. SHOULD BE SINEWAVE ≈14.2 V P-P
NOT OK
U35, U13, OR U12 DEFECTIVE. CHECK DIGITAL INPUTS.
OK
CHECK TP3. SHOULD BE SINEWAVE ≈12.8 V P-P
OK
NOT OK
U34, U11, OR U12 DEFECTIVE. CHECK DIGITAL INPUTS.
CHECK TP2 SHOULD BE SINEWAVE ≈11.6 V P-P
OK
NOT OK
U33, U11, OR U12 DEFECTIVE. CHECK DIGITAL INPUTS.
CHECK TP16. NO VOLTAGE.
OK
NOT OK
CHECK TP1. SHOULD BE SINEWAVE ≈11.6 V P-P
NOT OK
U9, U8, U23, T1, OR K1 DEFECTIVE.
U10 OR U9 DEFECTIVE. CHECK DIGITAL INPUTS.

Figure 6-2. Analog Troubleshooting Chart (Sheet 2 of 2)

SECTION 7

PARTS LIST

7-1 INTRODUCTION

This section contains replaceable parts lists, federal supply codes of manufacturers (FSCM), parts location diagrams, and a list of manufacturers of parts used for the Model 5310 Resolver/Synchro Simulator (SIM).

7-2 PARTS LIST

The parts list contains only replaceable parts for the Model 5310. It is prepared in tabular form and is divided into six columns as follows:

7-2.1 Column 1 - Ref Des. Lists alpha numerical reference designations for replaceable parts shown on schematic and parts location diagrams.

7-2.2 Column 2 - Description. Contains descriptions which identify replaceable parts.

7-2.3 Column 3 - NAI P/N. Lists North Atlantic Industries part numbers assigned to replaceable parts.

7-2.4 Column 4 - FSCM. Lists Federal Supply Code for Manufacturers. The FSCM identifies manufacturer or government agency whose number is listed in the manufacturer's part number column. If a FSCM is not assigned to a manufacturer, a five letter code is given and alphabetically referenced (AAAAA, BBBBB, etc.) to the list of Manufacturers table within this manual.

7-2.5 Column 5 - MFR P/N. Lists manufacturer's part numbers of replaceable parts or data to aid in determining parts substitution.

7-2.6 Column 6 - UOC (Usable on Code). This column contains codes to identify specific equipment configurations (model, assembly, etc.). When a part applies to all configurations, no coding system is used. The coding system is as follows: A, B, C,... and continues with double, AA through AZ, BA, BB, etc., when necessary.

7-3 LIST OF MANUFACTURERS

This list contains the names, addresses, FSCMs, and other identifying codes of manufacturers referenced in the parts list. It is arranged numerically using the manufacturer's FSCMs provided in the Federal Supply Code for Manufacturers, Cataloging Handbooks H4-1, H4-2, and H4-3.

The list is prepared in tabular form as follows:

a. Column 1 contains FSCMs of all manufacturers referenced in the parts list.

b. Column 2 contains the names and addresses of manufacturers applicable to FSCMs listed in column 1.

7-4 PARTS LOCATION ILLUSTRATIONS

Parts location illustrations are provided to give the user a quick and positive method for locating parts on specific assemblies being repaired. Each illustration provides corresponding location index numbers and each parts location diagram provides reference designations for circuit card components.

Table 7-1. Model 5310-XX - Common Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A1	Chassis Assembly	783878	07342	783878
A2	Front Panel/BCD Assembly	783879	07342	783879
	Mating Connector Kit Model 8300	783718	07342	783718
	Shell (1)		00779	205211-1
	Clamp (1)		00779	20732-1
	Retainer (2)		00779	205980-1
	Pins (50)		00779	66569-3
MP1	Cover, Top	206069	07342	206069
MP2	Cover, Bottom	500963	07342	500963

Table 7-2. Model 5310-F1X Feature 1, Option 1 - Parallel Interface Option - Unique Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A1A1W1	Main Circuit Card Assembly (CCA) to Main CCA Cable Assembly	783877	07342	783877
A2A1W2	BCD/Binary CCA to Main CCA Cable Assembly	783875	07342	783875
MP3	Panel, Blank	206095	07342	206095

Table 7-3. Model 5310-F2X Feature 1, Option 2 - NATIVE IEEE-488 Interface Option - Unique Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A2W2	BCD/Binary Converter Cable Assembly	787476	07342	787476
A3	IEEE-488 NATIVE CCA	787467-1	07342	787467-1
A3W1	IEEE-488 CCA to Main CCA Cable Assembly	787972	07342	787972
A3W2	IEEE-488 CCA to Main CCA Cable Assembly	787492	07342	787492

Table 7-4. Model 5310-F3X Feature 1, Option 3 - MATE/CIIL Interface Option - Unique Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A2W2	BCD/Binary Converter Cable Assembly	787476	07342	787476
A3	IEEE-488 MATE/CIIL CCA	787467-2	07342	787467-2
A3W1	IEEE-488 CCA to Main CCA Cable Assembly	787972	07342	787972
A3W2	IEEE-488 CCA to Main CCA Cable Assembly	787492	07342	787492
	Modification Kit	789160	07342	789160

Table 7-5. Model 5310-FX1 Feature 2, Option 1 - Frequency, 360 Hz-5000 Hz - Unique Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A1T3	Toroid Can Assembly	783880	07342	783880

Table 7-6. Model 5310-FX2 Feature 2, Option 2 - Frequency, 47 Hz-440 Hz - Unique Parts

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A1T3	Transformer Can Assembly	787092	07342	787092

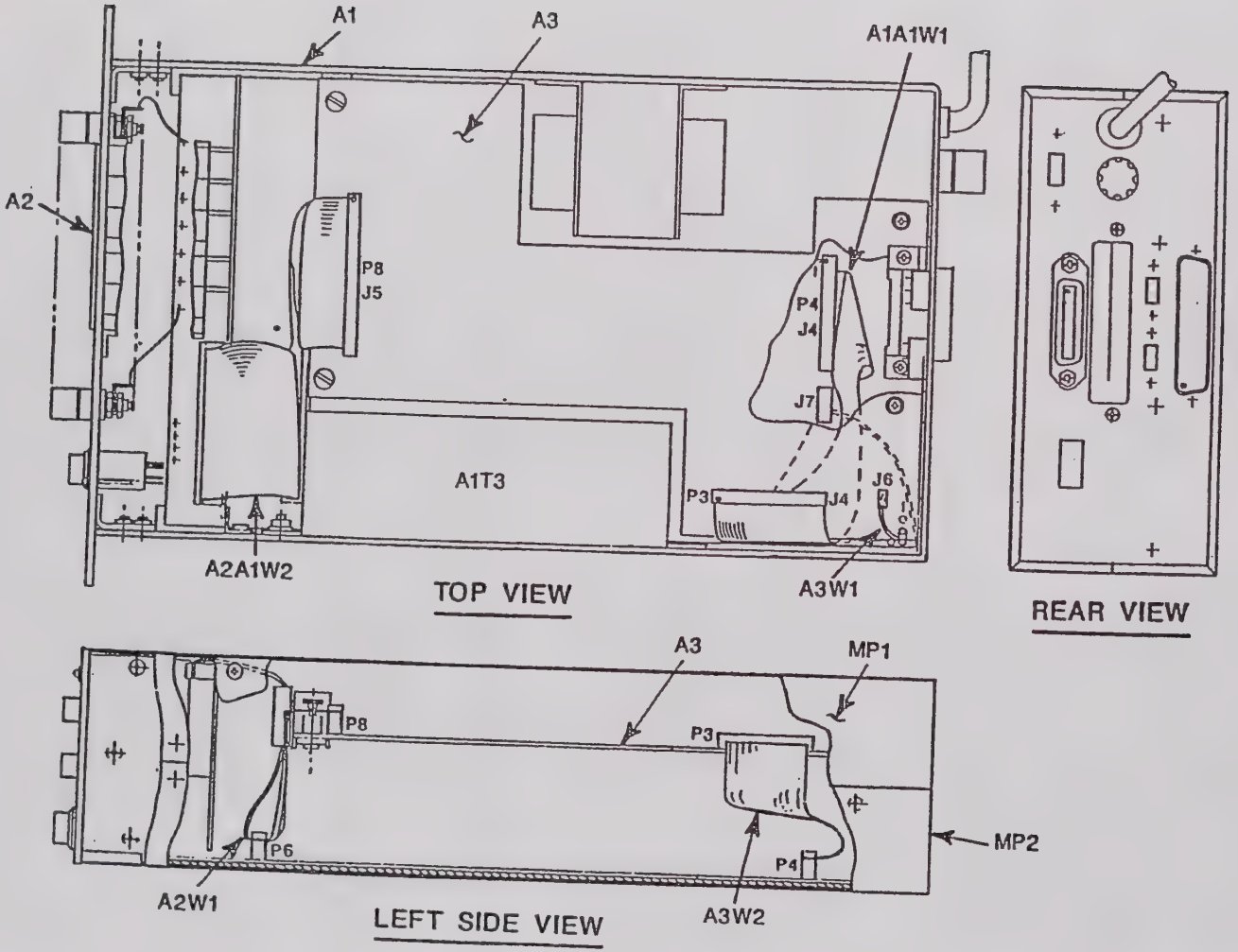


Figure 7-1. Model 5310 SIM, Parts Location Diagram

Table 7-7. Chassis Assembly A1 - 783878

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A1A1	5310 Main Circuit Card Assembly	783871-1	07342	783871
A1A2	4 Transistor/Spacer Assembly	783881	07342	783881
A1A3	3 Voltage Regulator/Spacer Assembly	783882	07342	783882
A1A4	Transistor Spacer Assembly	783883	07342	783883
A1A5	2 Voltage Regulator/Spacer Assembly	783884	07342	783884
A1F1	Fuse, Slo Blo, 1 Amp, 3 AG	803876	75915	313001
A1SW2	Switch, Slide, DPDT	808954	82389	4625LFR
A1SW3	Switch, DPDT, 3A	808944	79727	GF-126-3
A1SW4	Same as A1SW3			
A1T2	Transformer, Power: Primary, 115/230 V Secondary, 48 V CT @ 850 mA	808860	07342	808860
A1W1	Line Cord, 6 ft, 3 Conductor, 18 GA, Gray	884818	80126	C-2103076GY

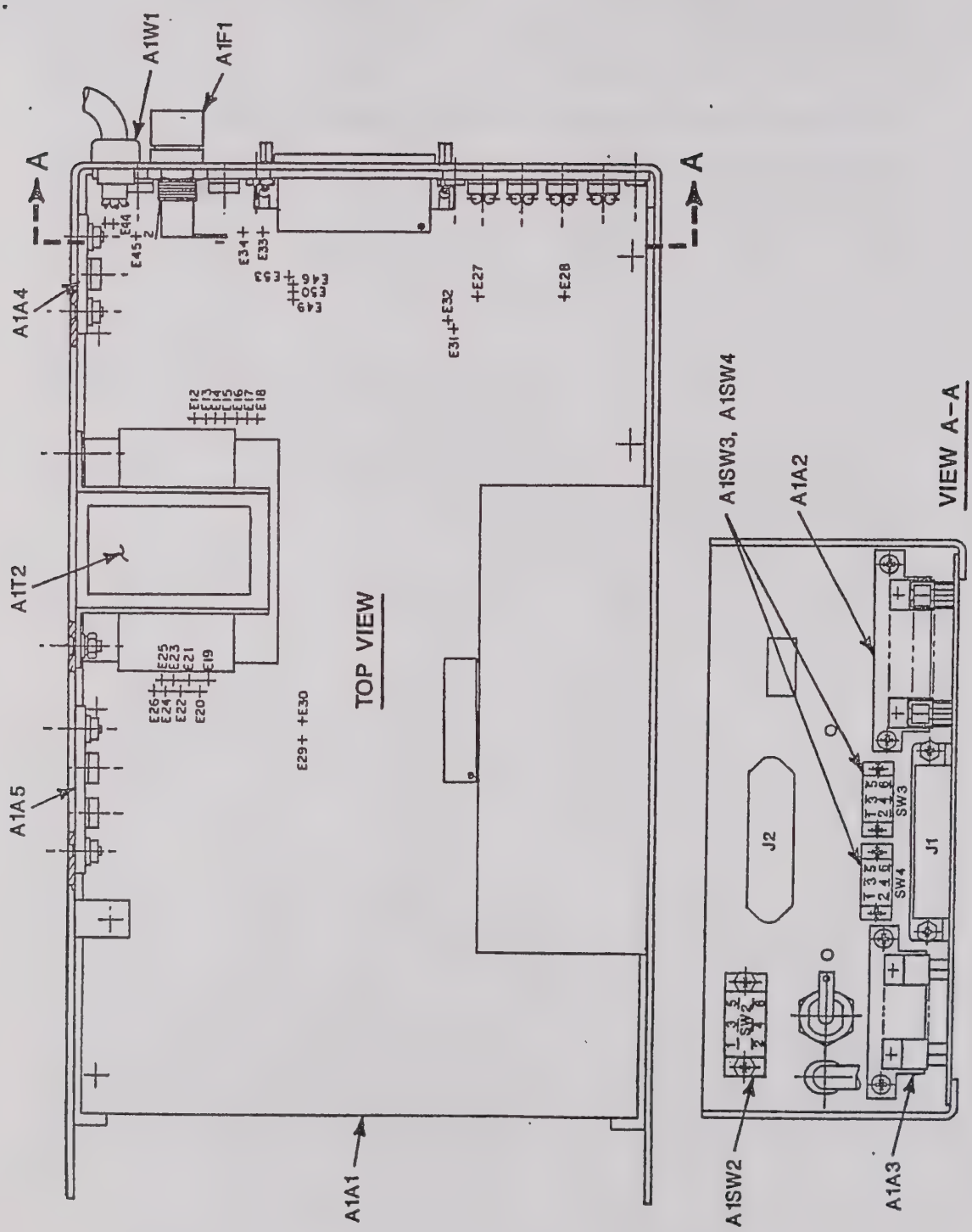


Figure 7-2. Chassis Assembly A1, Parts Location Diagram

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
C1-C6	Not used			
C7	Capacitor, Matched Set, 47 uf, 6 V, ±10%	808958	07342	808958
C8	Same as C7			
C9	Capacitor, Ceramic, 390 pf, 200 V, ±10%	805284	81349	CK05BX391K
C10	Same as C9			
C11	Capacitor, Ceramic, 0.01 uf, 100 WV dc, ±10%	808487	56289	CKR06BX103KL
C12	Same as C11			
C13	Capacitor, El, Aluminum, 3300 uf, 50 V, +50-10%	808908	56289	503D338F05-0UK
C14	Capacitor, El, Tantalum, 1 uf, 35 V, ±20%	807192	56289	196D105X903-5HA1
C15	Same as C13			
C16	Same as C14			
C17	Capacitor, El, Aluminum, 2200 uf, 50 V, +50-10%	808909	56289	503D228F05-0UJ
C18	Same as C14			
C19	Same as C17			
C20	Same as C14			
C21	Same as C17			
C22	Same as C14			
C23	Capacitor, Ceramic, 0.1 uf, 100 V, ±10%	880640	96095	CK06BX104K
C24-C35	Same as C23			
C36-C39	Not used			
C40	Capacitor, Ceramic, 0.047 uf, 100 V, ±10%	883330	81349	CK06BX473K

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
C41-C43	Same as C40			
C44	Capacitor, Ceramic, 2200 pf, 200 V, ±1%	808488	56289	CKR06BX222KL
C45	Same as C44			
C46	Capacitor, Ceramic, 0.0047 uf, 100 V, ±10%	883359	81349	CK05BX472K
CR1	Diode	804477	04713	1N4001
CR2-CR21	Same as CR1			
CR22	Diode, Zener, 24 V	880334	04713	1N5252B
CR23-CR27	Same as CR1			
J1	Connector, 50-pin	808198	00779	745099-2
K1	Relay, Form 2C, 24 V dc, Coil	808903	AAAAA	RB2E-DC24V
K2-K9	Same as K1			
R1	Resistor, Network, 201 k, 1/10 W, ±1%	808874	07342	808874
R2	Resistor, Metal Film, 3.09 M, 1/10 W, ±1%	808905	01121	CC3094F
R3	Resistor, Network, 36.124 k, 1/10 W, ±1%	(See R1)		
R4	Resistor, Network 30 k, 1/10 W, ±1%	(See R1)		
R5	Resistor, Metal Film, 5.11 k, 1/8 W, ±1%	806729	81349	RN55D5111F
R6-R9	Same as R5			
R10	Resistor, Composition, 27 k, 1/4 W, ±5%	880141	01121	CB2735
R11	Resistor, Composition, 4.7 k, 1/4 W, ±5%	880088	01121	CB4725
R12	Same as R11			

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1 (Continued)

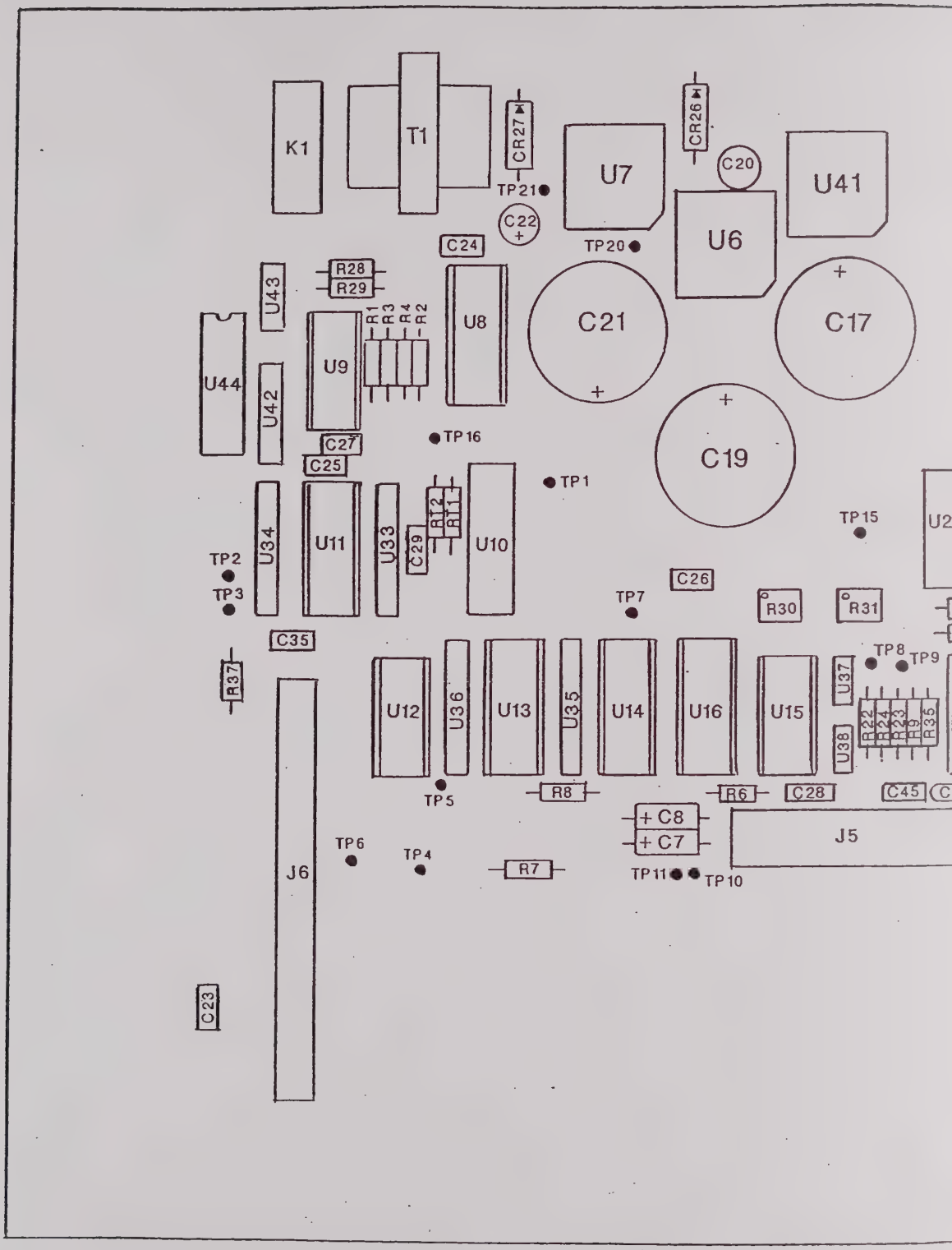
REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
R13	Same as R10			
R14	Resistor, Wirewound, 0.866 ohm, 1 W, ±1%	808981	91637	RW70UR866F
R15	Same as R14			
R16	Same as R10			
R17,R18	Same as R11			
R19	Same as R10			
R20,R21	Same as R14			
R22	Same as R5			
R23	Resistor, Metal Film, 10 k, 1/8 W, ±1%	880044	16299	NA55-10K
R24	Same as R23			
R25	Resistor, Composition, 3.9 k, 1/4 W, ±5%	801409	01121	CB3925
R26	Resistor, Composition, 3.3 k, 1/4 W, ±5%	803388	01121	CB3325
R27	Same as R26			
R28	Resistor, Composition, 10 k, 1/4 W, ±5%	880092	01121	CB1035
R29	Same as R28			
R30	Resistor, Variable, 100 k ohm, 13 turn	808690	80294	3279W-1-104
R31	Same as R30			
R32	Same as R26			
R33	Resistor, Composition, 1 k, 1/4 W, ±5%	880084	01121	CB1025
R34	Same as R28			
R35	Same as R33			

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
R36	Same as R28			
R37	Same as R26			
RT1	Same as U10			
RT2	Same as U10			
T1	Transformer, Reference, 115 V and 26 V	808866	07342	808866
U1-U5	Not used			
U6	IC, Bridge Rectifier	808938	14936	KBPC102
U7	Same as U6			
U8	IC, Linear Quad Analog Switch	808733	12040	LF13333N
U9	IC/L, Linear Quad OP Amp	808545	06665	OP11FY
U10	IC, Digital to Analog Converter w/Trim Assembly	500960	07342	500960
U11	IC, CMOS, Analog Multiplexer/ Demultiplexer	808227	02735	CD4052BE
U12	Same as U9			
U13	Same as U11			
U14	Same as U8			
U15	Same as U9			
U16	Same as U8			
U17	IC, TTL, Quad D Flip-Flop	883603	01295	SN74LS175N
U18-22	Same as U17			
U23	IC, CMOS, Quad Exclusive OR Gate	808091	04713	MC14070BP
U24	IC/L, Dual OP Amp	808945	34371	HA1-2655-5
U25	IC, TTL, Quad 2-Input OR Gate	808898	01295	SN74LS32N
U26	IC, CMOS, Dual 1 of 4 Decoder	808899	04713	MC14555BCP

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
U27	IC, Driver (Hex Peripheral)	808900	04713	MC1413P
U28	IC, Quad 2 Channel Data Selector	807780	04713	MC14519BCP
U29-U32	Same as U28			
U33	IC, Resistor Network (Coarse I)	808857	07342	808857
U34	Same as U33			
U35	IC, Resistor Network (Coarse II)	808858	07342	808858
U36	Same as U35			
U37	IC, Resistor Network, 10 k Pair	808859	07342	808859
U38	Same as U37			
U39	Not used			
U40	Same as U28			
U41	Same as U6			
U42	IC, Resistor Network (Sine)	808855	07342	808855
U43	IC, Resistor Network (Cosine)	808856	07342	808856
U44	Same as U8			
VP1	Varistor, 130 V	807699	03508	V130LA10A
VP2	Same as VP1			
VP3	Varistor	885027	06001	V33ZA1
VP4	Same as VP3			
VP5	Varistor	885028	06001	V68ZA2
VP6	Same as VP5			
VP7	Varistor	885029	06001	V100ZA3
VP8	Same as VP7			
VP9	Varistor	885030	06001	V180ZA1


K1
T1
CR27
CR26
U7
C20
U41
U6
TP21
C22
C24
TP20
R28
R29
U43
R1
R3
R4
R2
U8
C21
C17
U44
U9
U42
C27
C25
TP16
C19
TP1
TP15
U34
U11
U33
C29
R12
R11
U10
TP2
TP3
C26
TP7
R30
R31
C35
TP8
TP9
R37
U12
U36
U13
U35
U14
U16
U15
U37
U38
R22
R24
R23
R9
R35
TP5
R8
R6
C28
C45
+ C8
+ C7
J5
J6
TP6
TP4
R7
TP11
TP10
C23

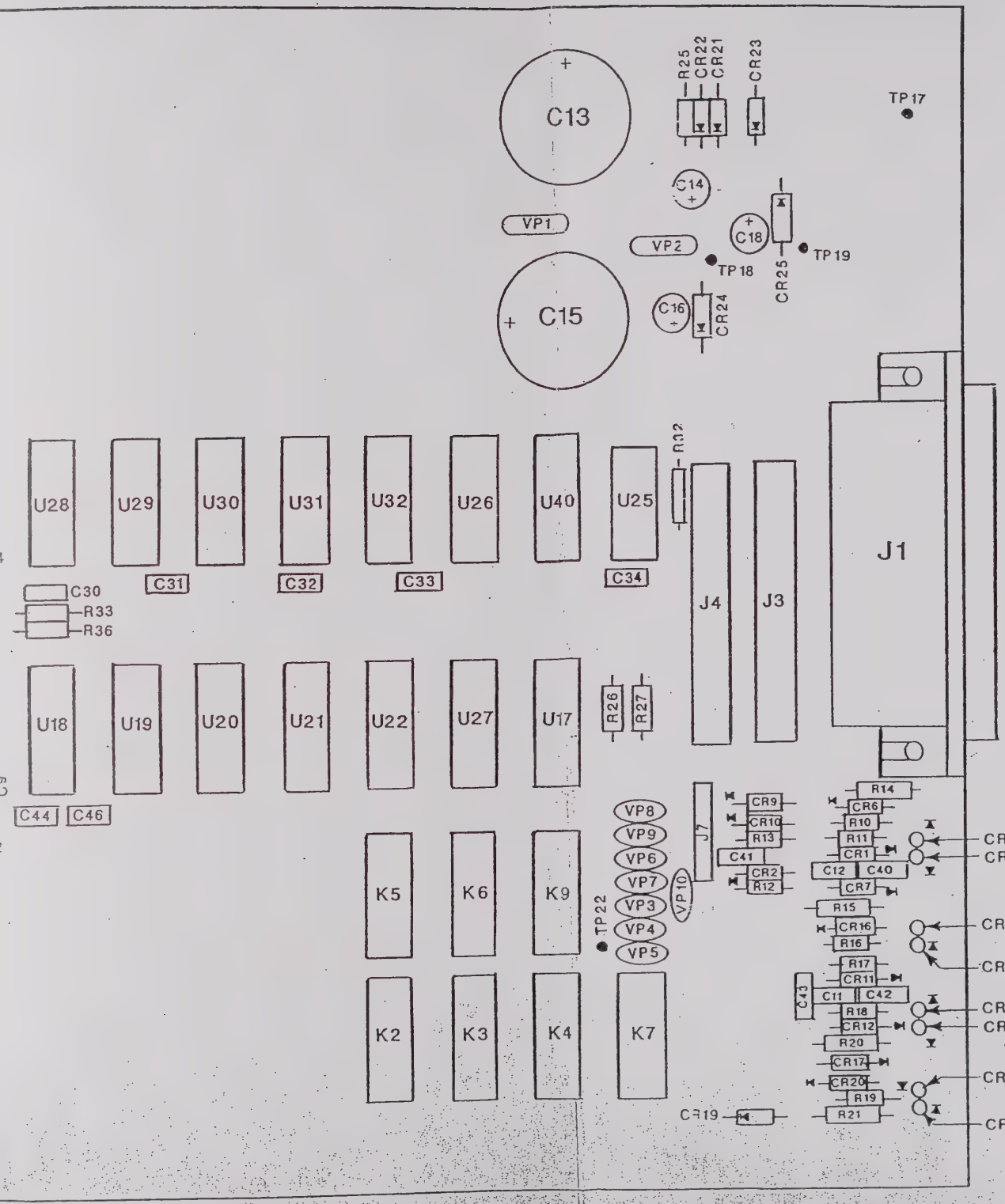


Figure 7-3. Main Circuit Card Assembly A1A1, Parts Location Diagram

Table 7-8. 5310 Main Circuit Card Assembly A1A1 - 783871-1 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
VP10	Same as VP9			
XU1-XU7	Not used			
XU8	Socket, 16-pin	808197	00779	2-640358-3
XU9	Socket, 14-pin	880166	00779	2-640357-3
XU10	Socket, 18-pin	808407	00779	2-640359-1
XU11	Same as XU8			
XU12	Same as XU9			
XU13,U14	Same as XU8			
XU15	Same as XU9			
XU16	Same as XU8			
XU17-XU23	Not used			
XU24	Same as XU9			

Table 7-9. Four Transistor/Spacer Assembly A1A2 - 783881

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
3	Transistor, Power, NPN, 60 VCEO, 40 W	808942	04713	T1P31A
4	Transistor, Power, PNP, 60 VCEO, 140 W	808943	04713	T1P31A
5	Same as Q3			
	Same as Q4			

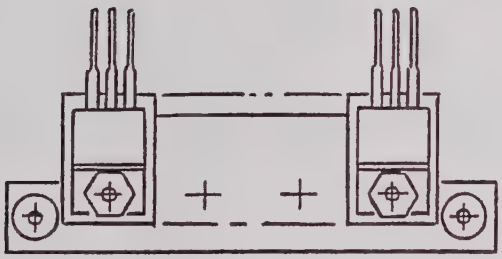


Figure 7-4. Four Transistor/Spacer Assembly A1A2, Parts Location Diagram

Table 7-10. Three Voltage Regulator/Spacer Assembly A1A3 - 783882

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
1	Voltage Regulator	883622	04713	MC7812CT
2	Voltage Regulator, +15 V, 1 Amp	808388	12040	LM340T1578 15UC
3	Voltage Regulator, -15 V, 1 Amp	808390	12040	LM7915TC

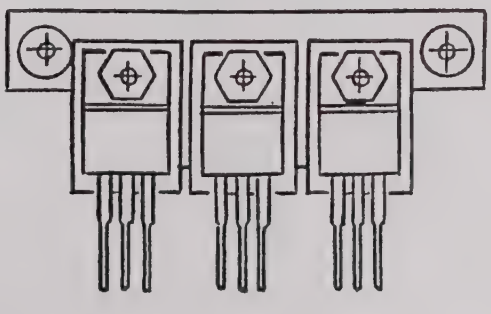


Figure 7-5. Three Voltage Regulator/Spacer Assembly A1A3, Parts Location Diagram

Table 7-11. Transistor Spacer Assembly A1A4 - 783883

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
Q1	Transistor, Power, NPN, 60 VCEO, 40 W	808942	04713	T1P31A

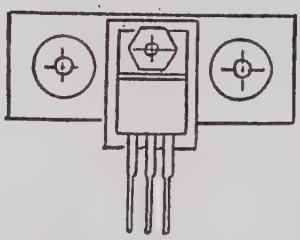


Figure 7-6. Transistor Spacer Assembly A1A4, Parts Location Diagram

Table 7-12. Two Voltage Regulator/Spacer Assembly A1A5 - 783884

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
U4	IC/L, Voltage Regulator, +5 V	808498	12040	LM3405-5.0
U5	IC/L, Voltage Regulator, -5 V	808901	27014	LM7905CT

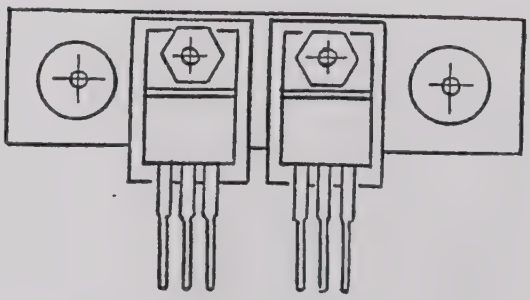
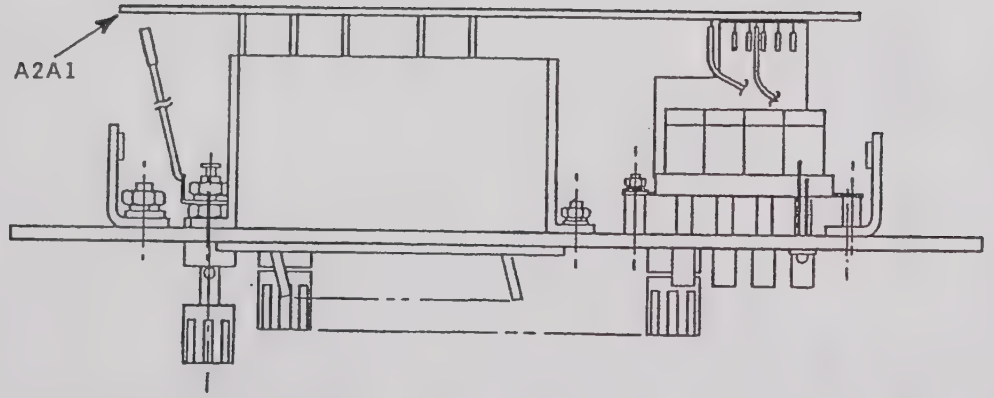


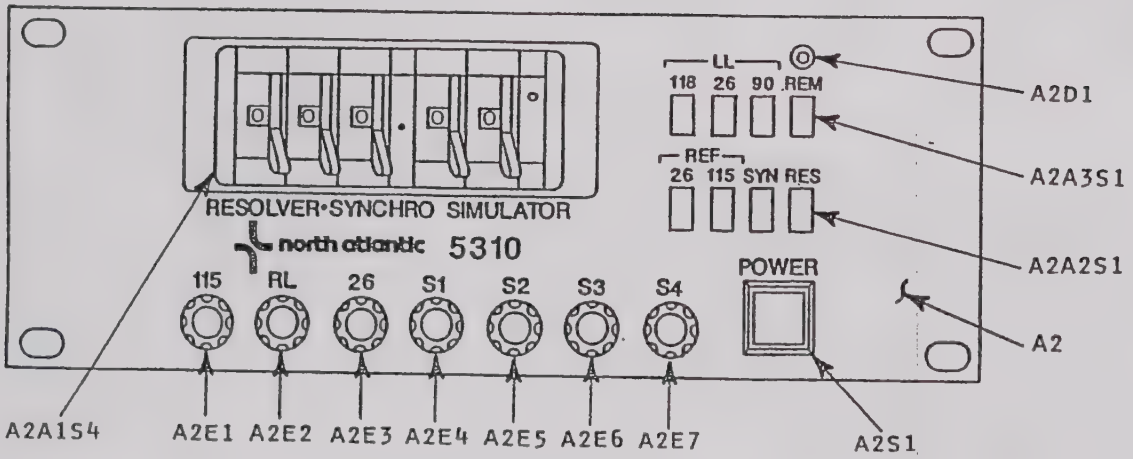
Figure 7-7. Two Voltage Regulator/Spacer Assembly A1A5, Parts Location Diagram

Table 7-13. Front Panel/BCD Circuit Card Assembly A2 - 783879

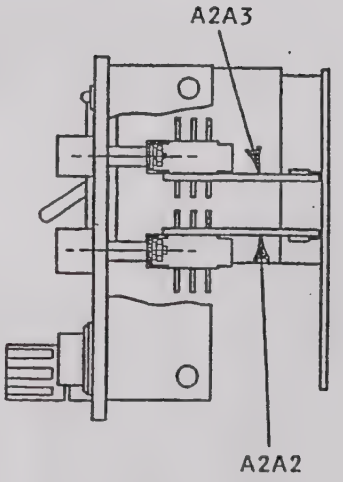
REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A2A1	BCD/Binary Converter Circuit Card Assembly	783870	07342	783870
A2A2	Synchro/Resolver Selector Switch Assembly	783873	07342	783873
A2A3	Line to Line Selector Switch Assembly	783874	07342	783874
A2D1	LED, Red	808894	50579	CQV11-6
A2E1	Binding Post, Red	800119	81073	29-1R
A2E2	Binding Post, Black	800120	81073	29-1B
A2E3-A2E7	Same as A2E1			
A2S1	Switch, Power, Push button (Illuminated)	808936	51420	881-2181-01A-7387



TOP VIEW



FRONT VIEW



LEFT SIDE VIEW.

Figure 7-8. Front Panel/BCD Assembly A2, Parts Location Diagram

Table 7-14. Replacement Parts List - BCD/Binary Converter CCA A2A1 - 783870

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
C1	Capacitor, Ceramic, 0.1 uf, 100 V, ±10%	880640	96095	CK06BX104K
C2,C3	Same as C1			
C4-C9	Not used			
C10,C11	Same as C1			
R1	Resistor, Composition, 300 ohm, 1/4 W, ±5%	803236	01121	CB3015
S4	Switch Assembly, BCD, 5 Decade	808896	07342	808896
S5-S8	Same as S4			
U1	IC, Quad 2 Channel Data Selector	807780	04713	MC14519BCP
U2-U5	Same as U1			
U6	IC, PROM, Programmed, 1 k by 8, BCD, MSB	888371	07342	888371
U7	Same as U6			
U8	IC, PROM, Programmed, 1 k by 8, BCD, LSB	888372	07342	888372
U9	Same as U8			
U10	IC, CMOS, Binary Adder	808890	04713	MC14008BCP
U11-U13	Same as U10			
U14	IC, CMOS, Triple OR Gate	808893	04713	MC14075BCP
U15	IC, CMOS, Triple AND Gate (3 input)	808892	04713	MC14073BCP
U16	IC, CMOS, Quad 2 Input AND Gate	808436	04713	MC14081BCP
U17	IC, CMOS, Hex Inverter	808090	04713	MC14069OBCP
U18	Same as U16			

Table 7-14. Replacement Parts List - BCD/Binary Converter CCA A2A1 - 783870 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
U19	IC, Resistor Network, 100 k ohm, 9 Res	808581	32997	4310R-101-104
U20	Same as U19			
XU1-XU5	Not used			
XU6	IC, Socket, 28-pin, DIP	883951	00779	2-640362-3
XU7-XU9	Same as XU6			

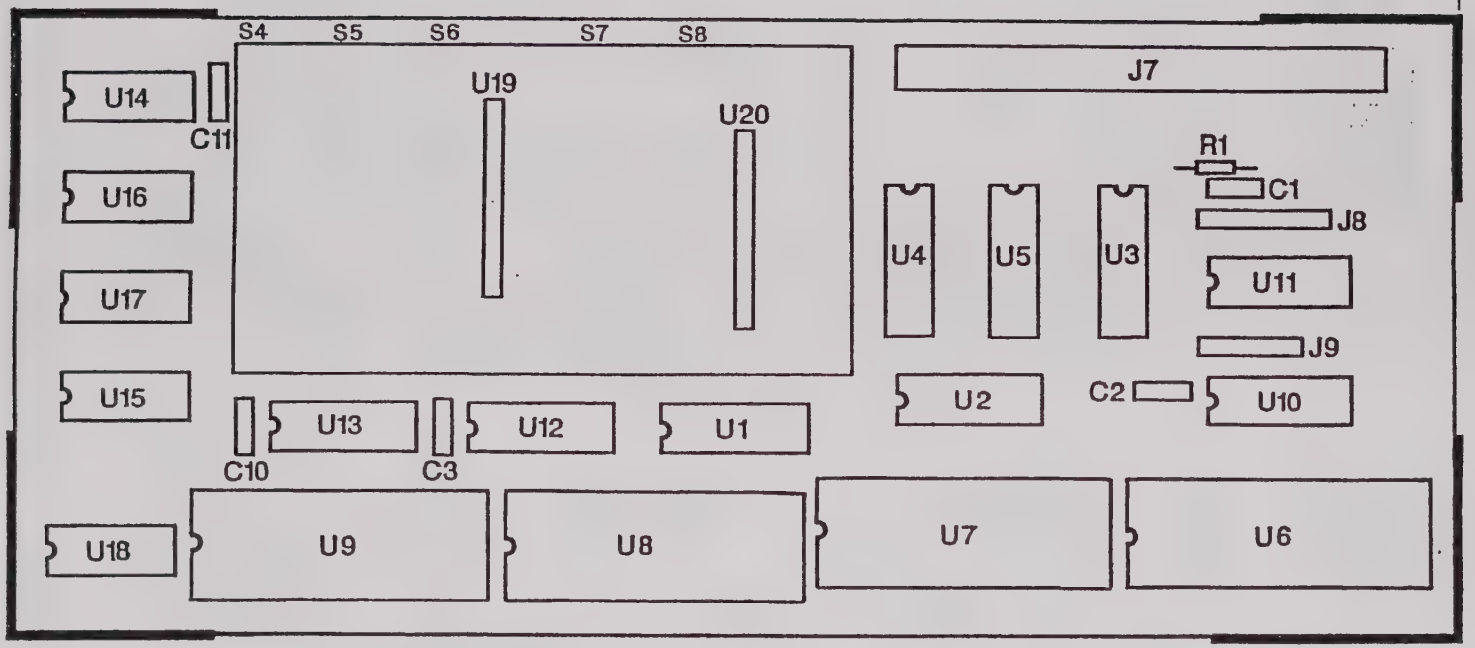


Figure 7-9. BCD/Binary Converter CCA A2A1, Parts Location Diagram

Table 7-15. Synchro/Resolver Selection Switch Assembly A2A2 - 783873

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
S1	Switch, Push button, 4 Station	808956	07342	808956

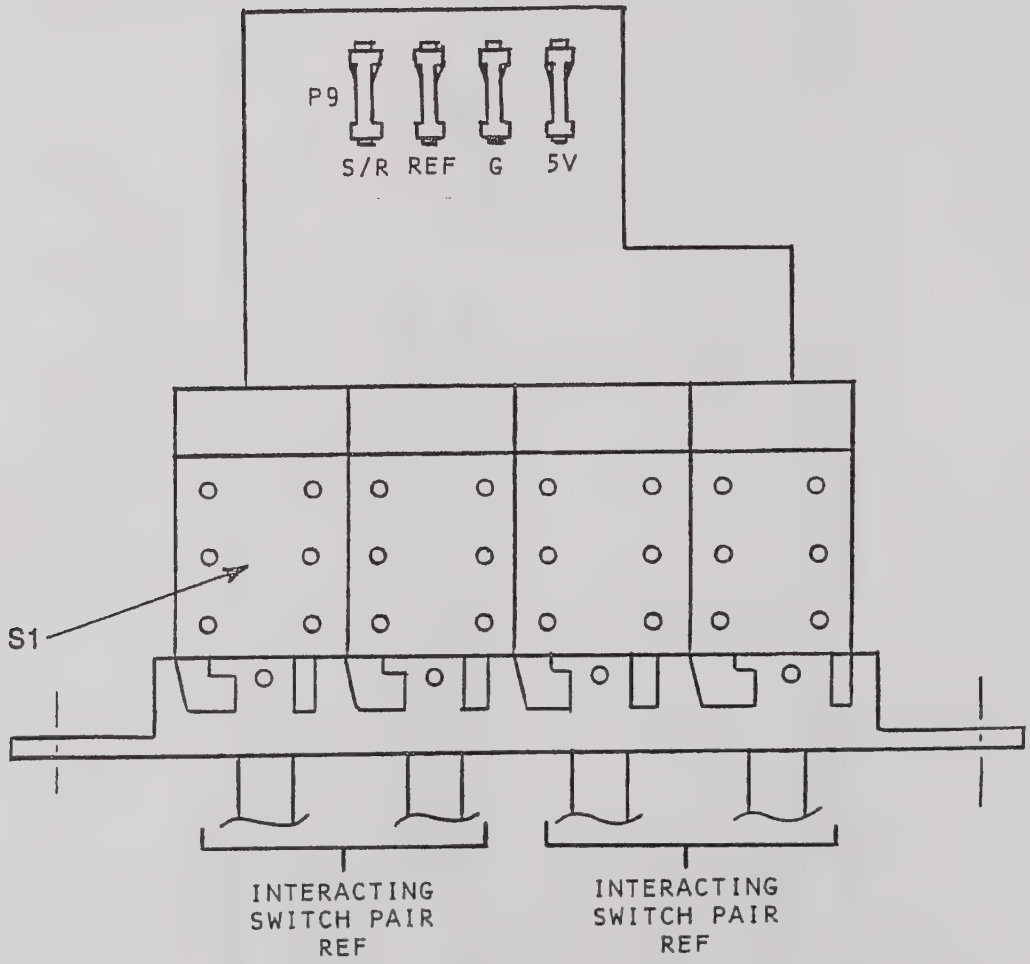


Figure 7-10. Synchro/Resolver Selection Switch Assembly A2A2, Parts Location Diagram

Table 7-16. Line-to-Line Selection Switch Assembly A2A3 - 783874

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
R2	Resistor, Composition, 100 k, 1/4 W, ±5%	880846	01121	CB1045
R3	Same as R2			
R4	Resistor, Composition, 10 k, 1/4 W, ±5%	880092	01121	CB1035
S1	Switch, Push button, Double Pole, 4 Station	808934	07342	808934

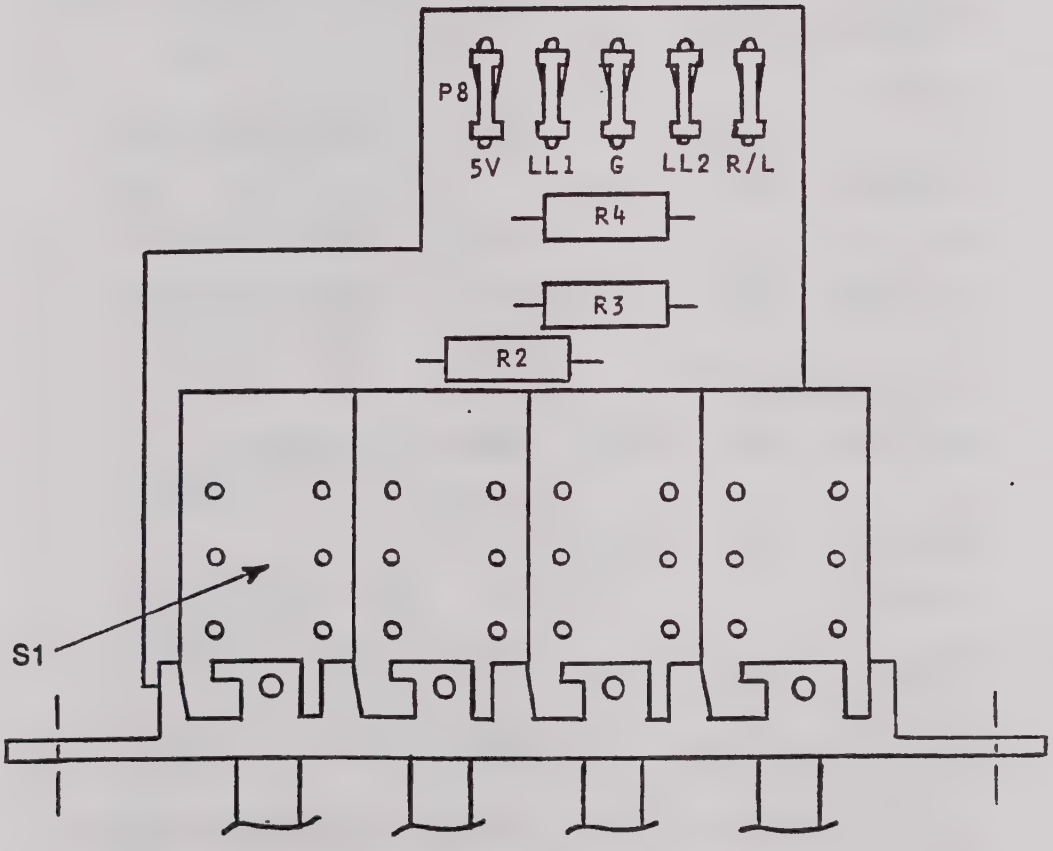


Figure 7-11. Line-to-Line Selection Switch Assembly A2A3, Parts Location Diagram

Table 7-17. Replacement Parts List - IEEE-488 Interface Circuit Card Assembly A3 - 787467-1, -2

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N	UOC
A3	NATIVE IEEE-488 Interface Circuit Card Assembly	787467-1	07342	787467-1	A
A3	IEEE-488 MATE/CIIL Interface Circuit Card Assembly	787467-2	07342	787467-2	B
C1	Capacitor, EL, Tantalum, 1 uf, 35 V, ±10%	801343	81349	CS13BF105K	
C2	Capacitor, EL, Tantalum, 10 uf, 20 V, ±20%	880073	06751	TS2K-20-106	
C3	Capacitor, Ceramic, 1 uf, 25 V, +80-20%	880032	72982	5815000Y5U0104Z	
C4-C12	Same as C3				
C13,C14	Capacitor, Fixed, Mica, 50 pf, 500 V, ±5%	803638	14655	DM-10-500J	B
CR1	Diode, SIG, IN	505805	81349	JAN1N4148	
CR2	Diode, Power/Rectifier	808787	81349	JAN1N4001	B
J2	Connector, Receptacle, 24 Pin, RT Angle	808966	00779	522791-1	
K1	Relay, SPST, SIP, 5 V Coil	888067	AAAAA	4705	B
Q1	Transistor, Signal, NPN, TO-18	805062	04713	2N2222	B
Q2	Same as Q1				
R1	Resistor, Composition, 75 k, 1/4 W, ±5%	882402	81349	RCR070753JP	
R2	Resistor, Composition, 470 ohm, 1/4 W, ±5%	880567	01121	CB4715	
R3	Resistor, Composition, 100 k, 1/4 W, ±5%	880846	81349	RNR50K26R7FM	B
R4	Resistor, Composition, 3.9 k, 1/4 W, ±5%	882397	81349	RCR07G392JP	B
S1	Switch, Slide, DIP, 6 Pos, Edge Activated	808918	81073	76PSB06	

Table 7-17. Replacement Parts List - IEEE-488 Interface Circuit Card Assembly A3 - 787467-1, -2 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N	UOC
U1	IC, Octal D Flip-Flop with Tristate Outputs	886833	01295	74HC374	
U2	Same as U1				
U3	IC, Octal Buffer/Line Driver with Tristate Outputs	886834	01295	74HC244	
U4	Same as U1				
U5	IC, CMOS, Monostable Multivibrator	886840	04713	MC14538	B
U6	PAL, Programmed, 5310	888662	07342	888662	
U7	IC, CMOS, Microprocessor	886828	81349	80C85	
U8	IC, Octal Transparent Latch with Tristate Outputs	886829	01295	74HC373	
U9	EPROM, Programmed, 5310 IEEE-488 NATIVE Mode	888664	07342	888664	A
U9	EPROM, Programmed, 5310 IEEE-488 (MATE/CIIL)	888663	07342	888663	B
U10	Same as U3				
U11	IC, Interface, Octal General Purpose Interface BUS Transceiver	885998	01295	SN75161A	
U12	IC, Interface, Octal General Purpose Interface BUS Transceiver	885997	01295	SN75160A	
U13	IC, IEEE-488 Controller	885996	01295	TMS9914A	
U14	IC, Static RAM, 2 k x 8, 120 us	886097	81349	MSM-5128-12	
U15	IC, Microcomputer, 1 k RAM, with I/O Ports and Timer	887862	BBBBB	MSM81C55	
U16	IC, CMOS, Quad NAND Gate	888129	01295	SN74NC00N	
U17	IC, Thermostat, 90°C, ±5°C	888066	33533	66L090	B
XU9	IC, Socket, DIP, 28 pin	883951	00779	2-640362-3	
Y1	Crystal, 4 MHz	808336	62712	DS400	
Z1	Resistor Package, 6/3.3 k	886835	16299	MC800133O1J	

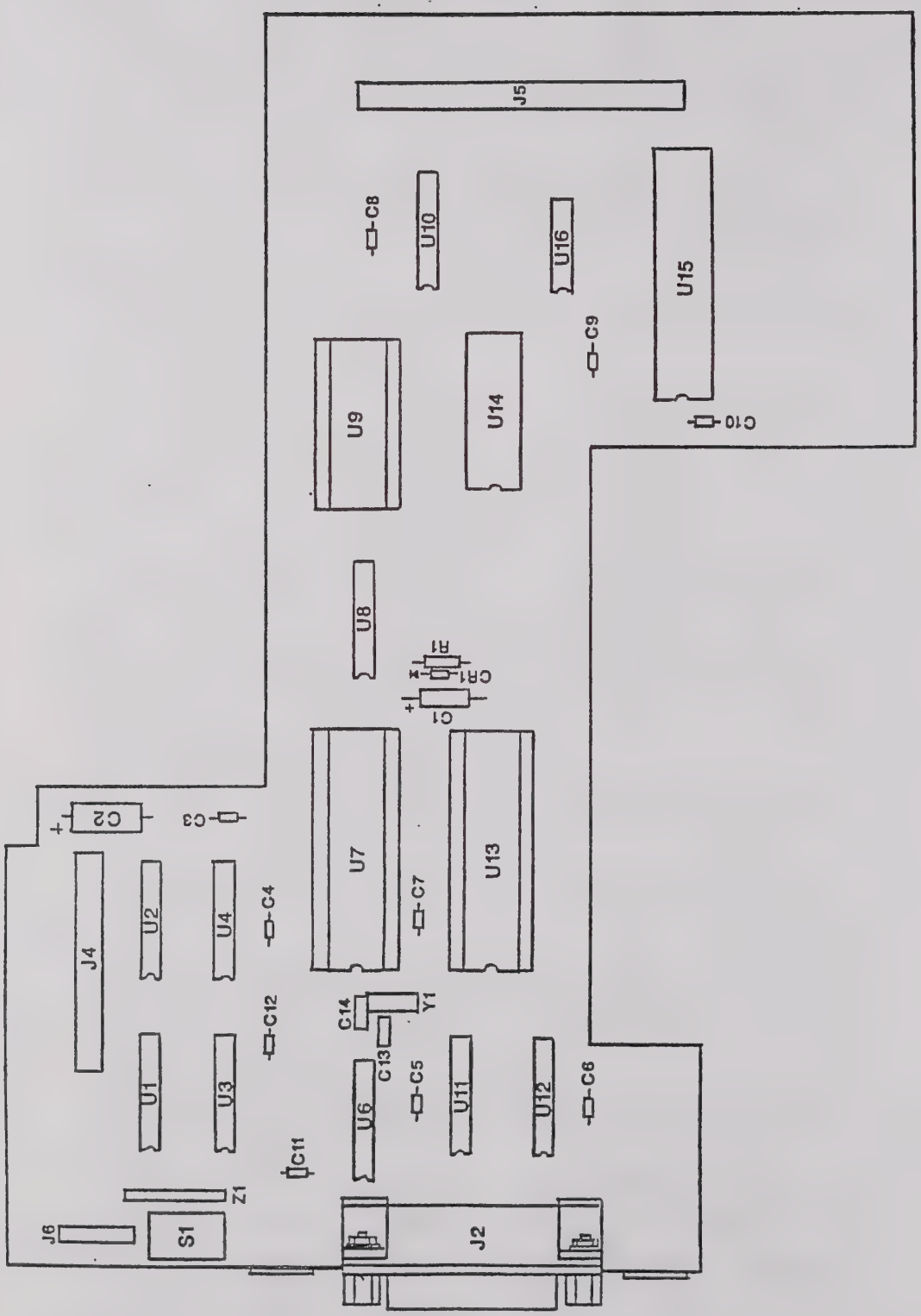


Figure 7-12. IEEE-488 Interface Circuit Card Assembly A3
(P/N 787467-1) Parts Location Diagram

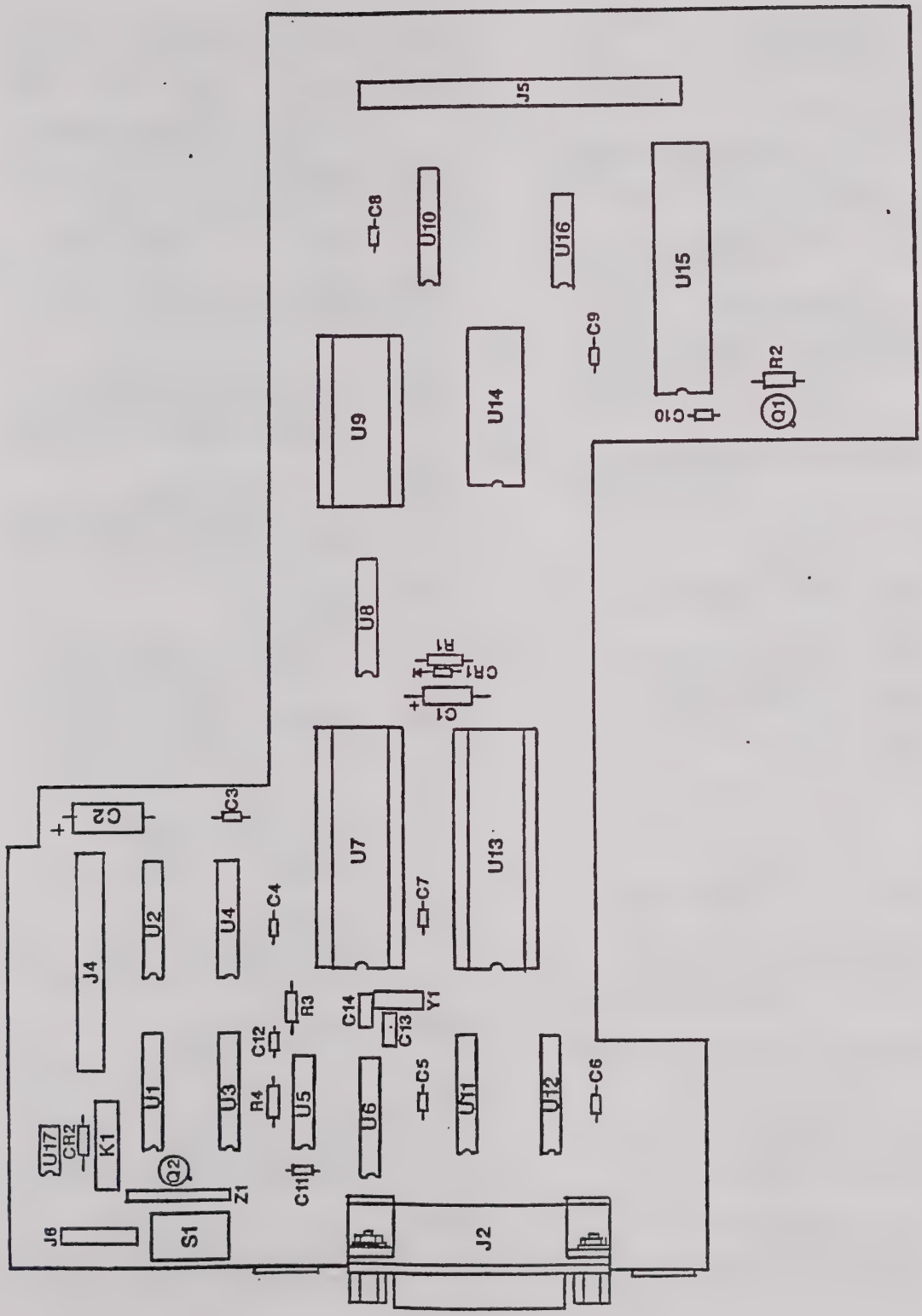


Figure 7-13. IEEE-488 MATE/CIIL Interface Circuit Card Assembly A3 (P/N 787467-2), Parts Location Diagram

Table 7-18. List of Manufacturers

Code	Name and Address
00779	AMP Inc. 2800 Fulling Mill P.O. Box 3608 Harrisburg, Pennsylvania 17105
01121	Allen-Bradley Co. 1201 S. 2nd Street Milwaukee, Wisconsin 53204
01295	Texas Instruments 13500 North Central Expressway Dallas, Texas 75265
02735	RCA - Solid State Route 202 Somerville, New Jersey 08876
03508	General Electric Co. Semiconductor West Genesee St. Auburn, New York 13021
04713	Motorola, Inc. 5005 E. McDowell Road Phoenix, Arizona 85008
06001	General Electric Co. P.O. Box 1388 Columbia, South Carolina 29201
00815	Midland-Ross Corp. 357 Beloit Street Burlington, Wisconsin 53105
06665	Precision Monolithics Inc. 1500 Space Pk Drive Santa Clara, California 95050
06751	Components, Inc. Semcor Division Phoenix, Arizona
07342	North Atlantic Industries, Inc. 60 Plant Avenue Hauppauge, New York 11788
09922	Burndy Corporation Richards Avenue Norwalk, Connecticut 06856
12040	National Semiconductor Corp. Commerce Drive Danbury, Connecticut 06810
14655	Cornell-Dubilier Electronics One Interchange Plaza Wayne, New Jersey 07470
14936	General Instrument Corp. 600 W. John Street Hicksville, New York 11802
16299	Corning Glass Works 3900 Electronics Drive Raleigh, North Carolina 27604
27014	Natl Semiconductor 2900 Semiconductor Dr. Santa Clara, California 95051
32997	Bourns, Inc. Trimpot Div. 1200 Columbia Ave. Riverside, California 92507
33533	The Brenco Corp. 1470 S. Vandeventer St. St. Louis, Missouri 63110
34371	Harris Semiconductor 200 Palm Bay Blvd. Melbourne, Florida 32901
50579	Litronix, Inc. 19000 Homestead Road Cupertino, California 95014
51429	Compu-Lite Corp. 711-F12 W. 17th St. Costa Mesa, California 92627
56289	Sprague Electric 87 Marshall Street North Adams, Massachusetts 01247
62712	Seiko Instruments USA 2990 Lomita Boulevard Torrance, California 90505-5102

Table 7-18. List of Manufacturers (Continued)

Code	Name and Address
72982	Murata Erie North America Inc. 645 W. 11th Street Erie, Pennsylvania 16512
75915	Tracor Littelfuse, Inc. 800 E. Northwest Highway Des Plaines, Illinois 60016
79727	C-W Industries 130 James Way Southampton, Pennsylvania 18966
80126	Pacific Electricord Co. 747 W. Redondo Beach Gardena, California 90247
80294	Bourns Instruments Inc. 135 Magnolia Avenue Riverside, California 92506
81073	Grayhill, Inc. P.O. Box 373 561 Hillgrove Ave LaGrange, Illinois 60525
81349	Military Specifications promulgated by Military Depts./Agencies under Authority of Defense Standardization Manual
82389	Switchcraft, Inc. 5555 N. Elstron Avenue Chicago, Illinois 60630
91637	Dale Electronics Inc. P.O. Box 609 Columbus, Nebraska 68601
95750	Republic Electric Industries Inc. 575 Broad Hollow Road Melville, New York 11747
96095	AVX Ceramics Div. of AVX Corp. Seneca Avenue Olean, NY 14760
AAAAA	Aromat 250 Sheffield Avenue Mountain Side, New Jersey 07092
BBBBB	OKI Electronics of America 4031 NE 12th Terrace Ft. Lauderdale, Florida 33334

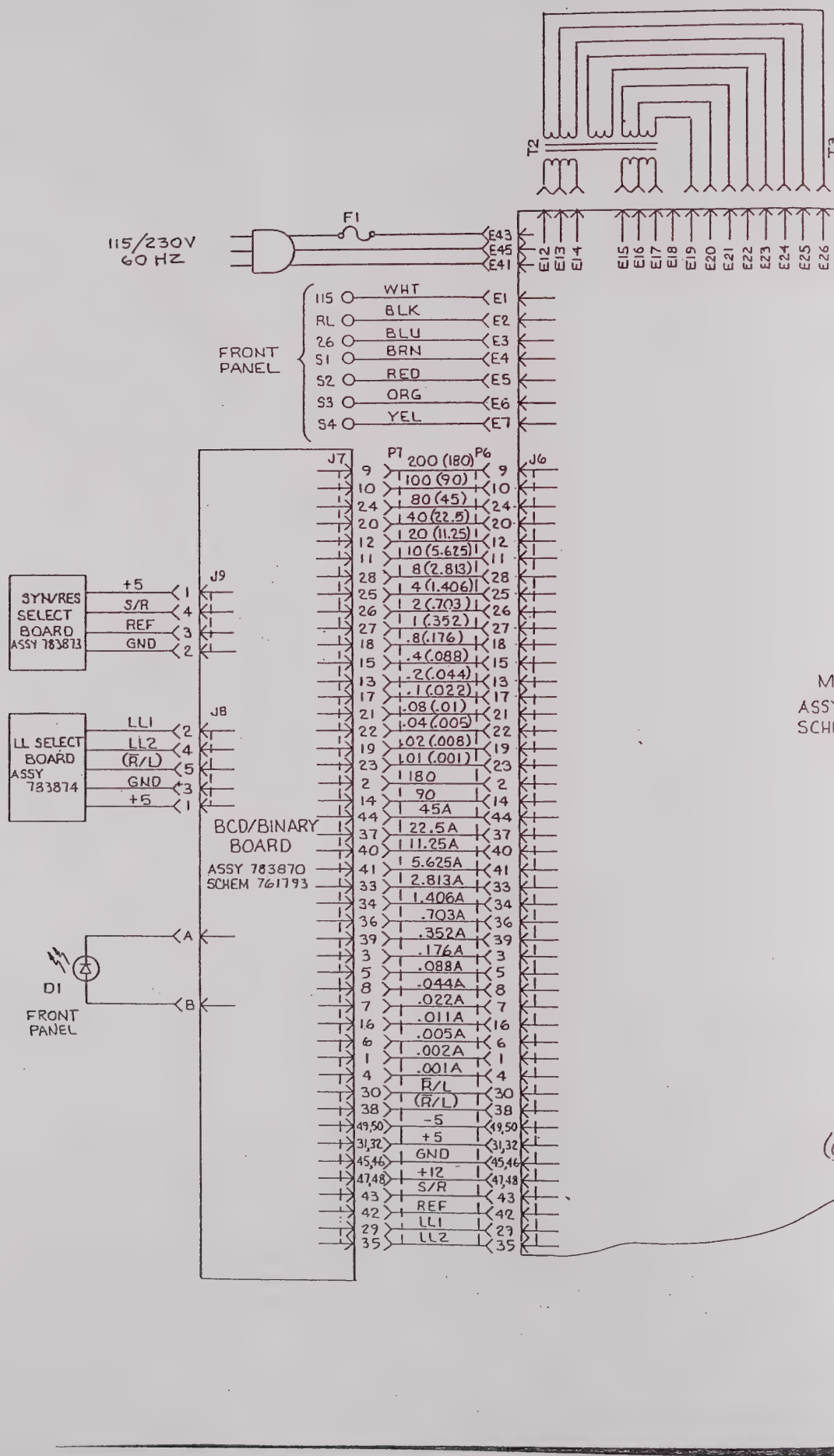
SECTION 8

SCHEMATIC DIAGRAMS

8-1 INTRODUCTION

This section contains schematic diagrams for the Model 5310 SIM.

FIGURE	TITLE	PAGE
8-1	5310 Interconnection Diagram	8-3
8-2	Main Circuit Card Assembly (CCA) - A1A1, Schematic Diagram	8-7
8-3	BCD/Binary Converter CCA - A2, Schematic Diagram	8-13
8-4	IEEE-488 Interface CCA - A3, Schematic Diagram	8-17
8-5	IEEE-488 MATE/CIIL CCA - A3, Schematic Diagram	8-19


T2
F1
115/230V
60 HZ
E43
E45
E41
E12
E13
E14
E15
E16
E17
E18
E19
E20
E21
E22
E23
E24
E25
E26
FRONT
PANEL
115
RL
26
S1
S2
S3
S4
WHT
BLK
BLU
BRN
RED
ORG
YEL
E1
E2
E3
E4
E5
E6
E7
J7
P7
200 (180)
P6
J6
100 (90)
80 (45)
40 (22.5)
20 (11.25)
10 (5.625)
8 (2.813)
4 (1.406)
2 (.703)
1 (.352)
.8 (.176)
.4 (.088)
.2 (.044)
.1 (.022)
.08 (.01)
.04 (.005)
.02 (.008)
.01 (.001)
180
90
45A
22.5A
11.25A
5.625A
2.813A
1.406A
.703A
.352A
.176A
.088A
.044A
.022A
.011A
.005A
.002A
.001A
R/L
(R/L)
-5
+5
GND
+12
S/R
REF
LL1
LL2
BCD/BINARY
BOARD
ASSY 783870
SCHEM 761793
J9
SYN/RES
SELECT
BOARD
ASSY 783873
+5
S/R
REF
GND
J8
LL SELECT
BOARD
ASSY
783874
LL1
LL2
(R/L)
GND
+5
A
B
D1
FRONT
PANEL

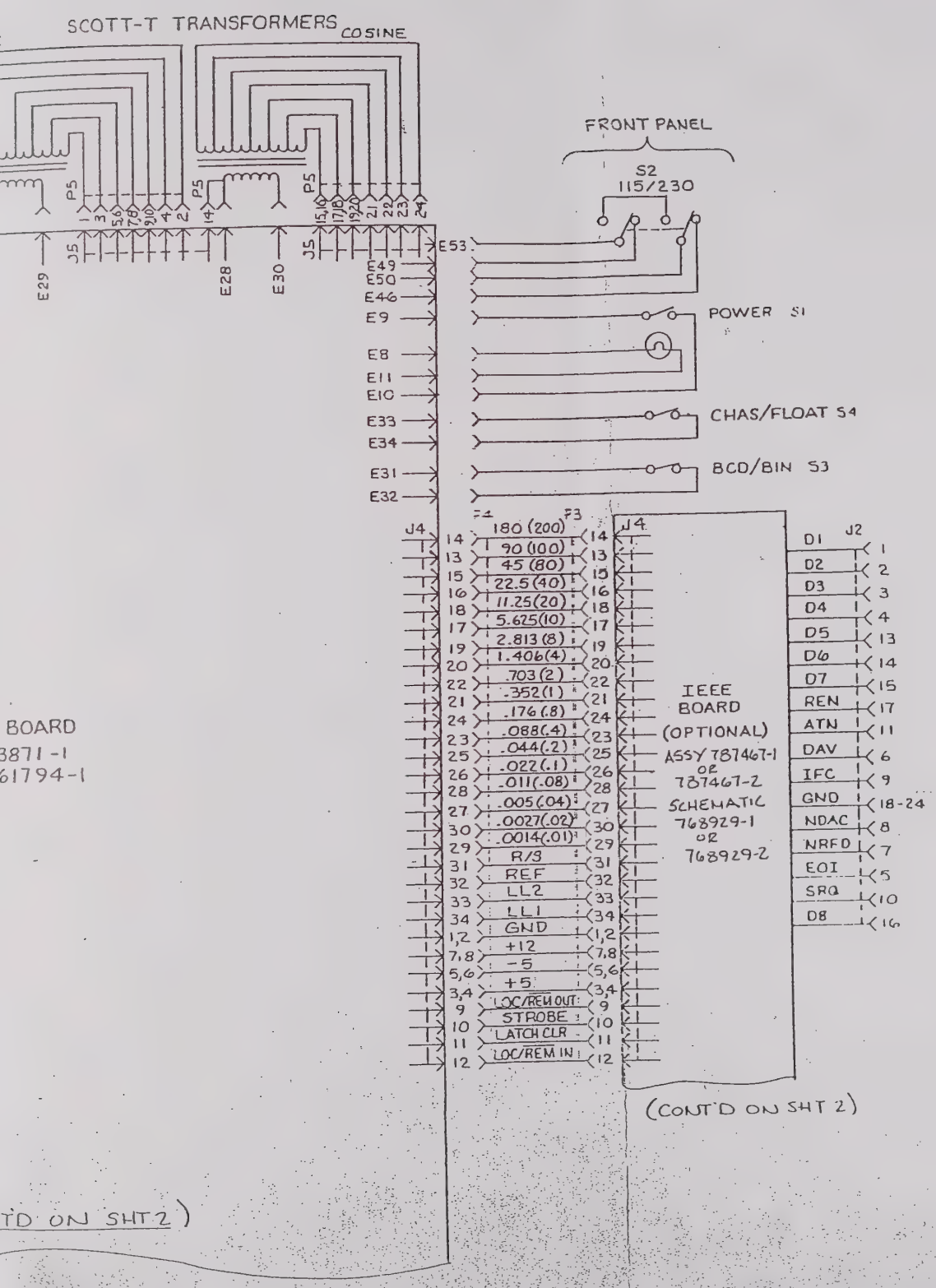


Figure 8-1. Model 5310 Interconnection Diagram 761798/E (Sheet 1 of 2)

(CONT'D FROM SHT. 1)
J1
6 180(200)
17 90(100)
33 45(80)
50 22.5(40)
16 11.25(20)
32 5.625(10)
49 2.813(8)
15 1.406(4)
31 .703(2)
48 .352(1)
14 .176(8)
30 .088(4)
47 .044(2)
13 .022(1)
29 .011(.08)
46 .005(.04)
12 .0027(.02)
28 .0014(.01)
45 LL1
42 LL2
41 REF
40 S/R
1 DIGITAL GND
9 CHAS GND
4 PWR IN HI
2 PWR IN LO
3 S3
35 S1

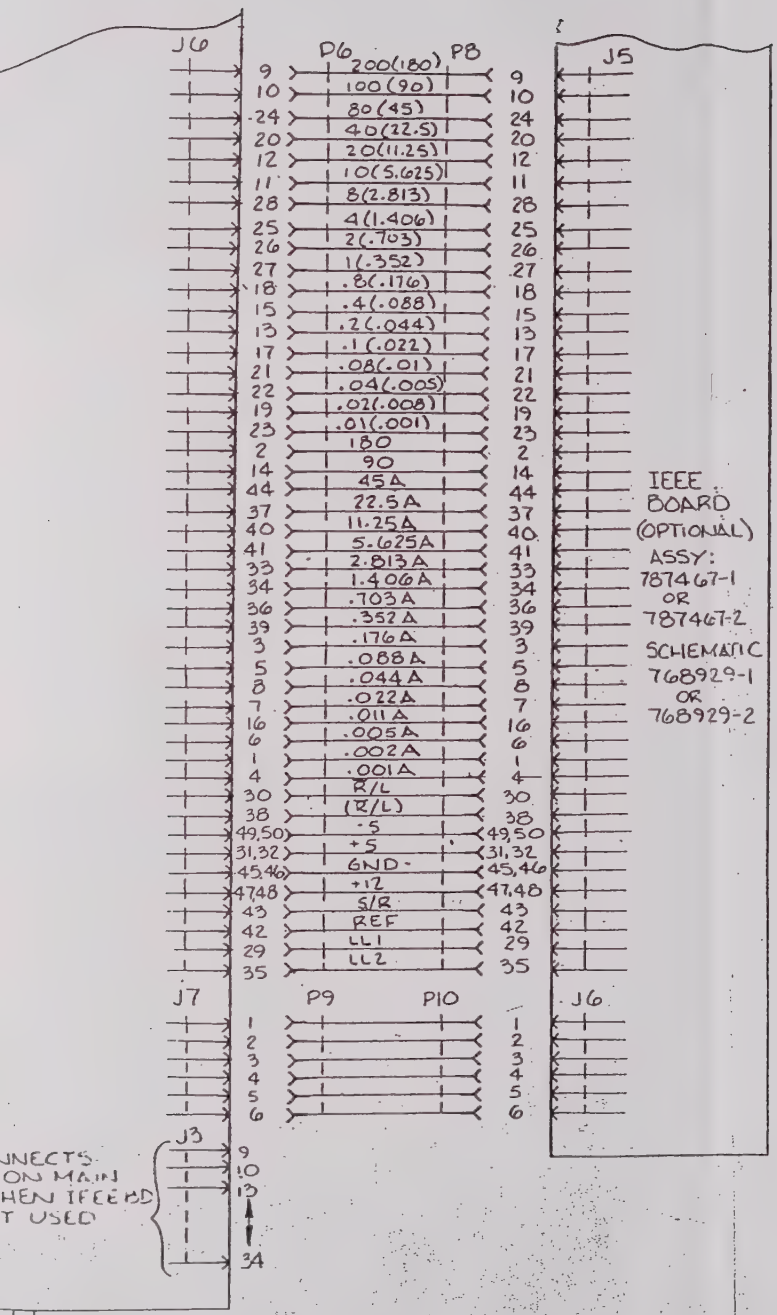
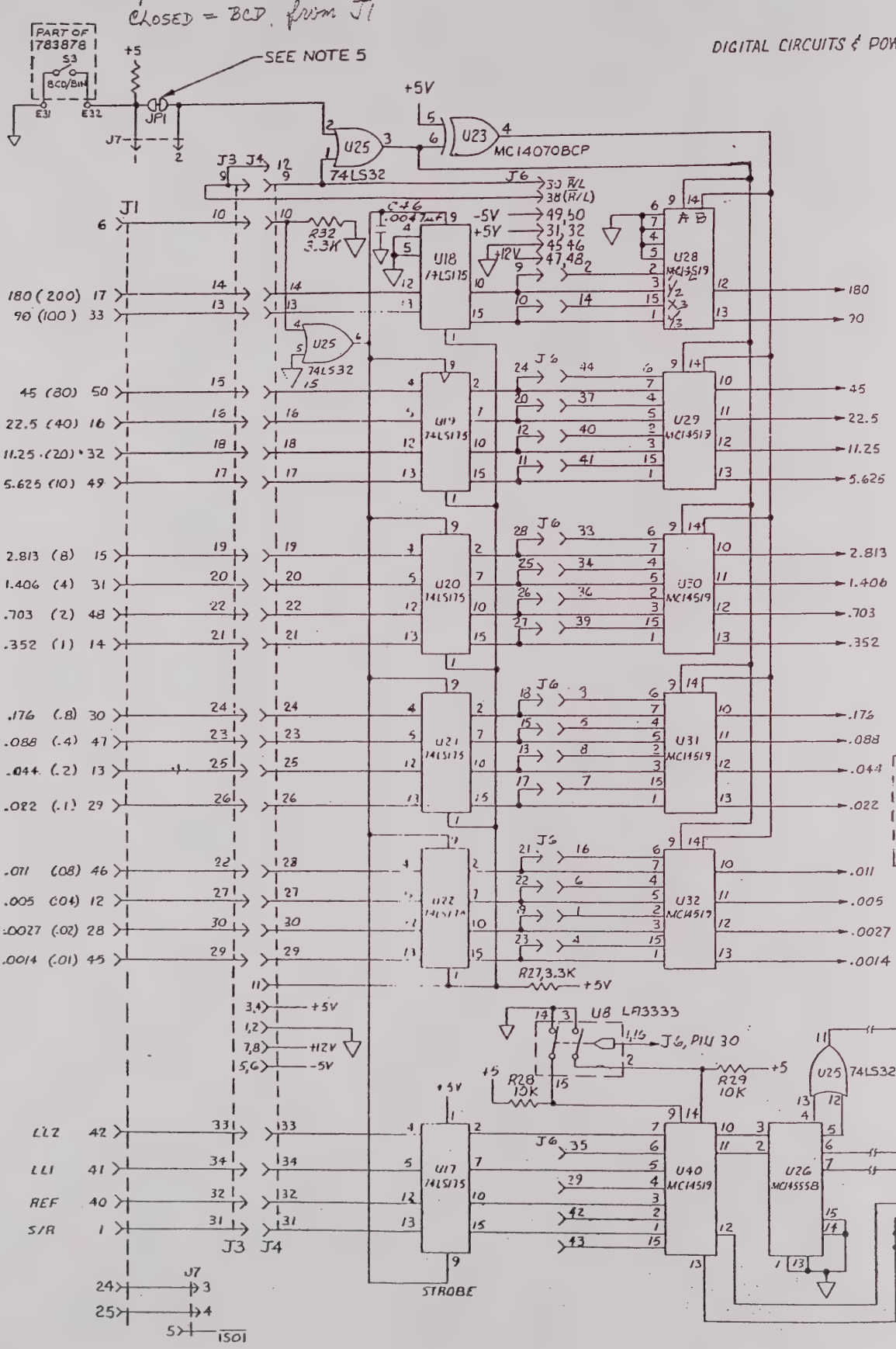
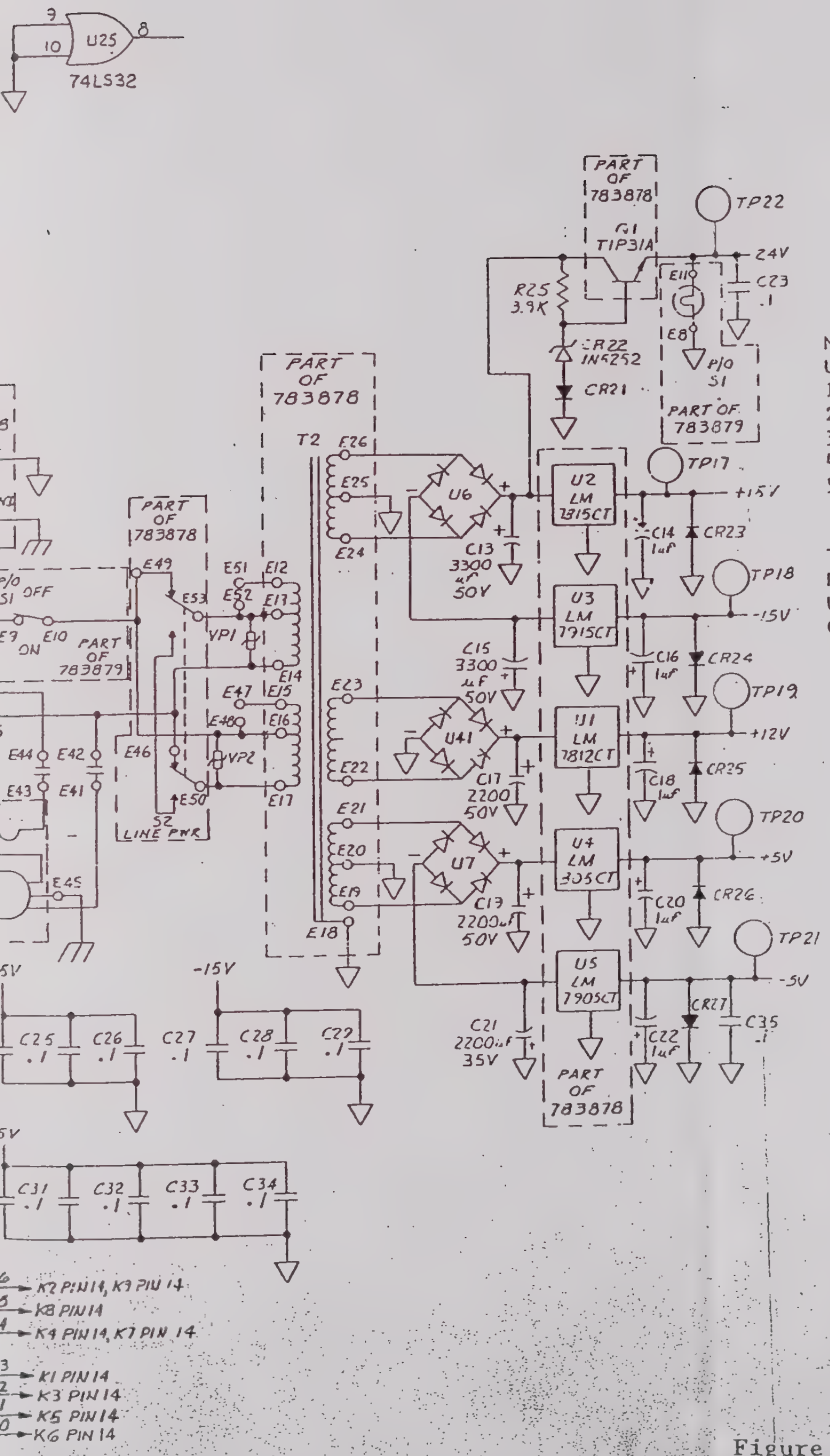


Figure 8-1. Model 5310 Interconnection Diagram 761798/E (Sheet 2 of 2)


CLOSED = BCD. from J1
PART OF 783878
S3
BCD/BIN
E31
E32
+5
SEE NOTE 5
JP1
J7
J3 J4
U25
74LS32
+5V
U23
MC14070BCP
J6
30 R/L
38 (R/L)
J1
C46
.004 µF
-5V
+5V
+12V
U18
74LS175
R32
3.3K
U28
MC14519
180 (200) 17
90 (100) 33
180
90
45 (80) 50
22.5 (40) 16
11.25 (20) 32
5.625 (10) 49
U19
74LS175
U29
MC14519
45
22.5
11.25
5.625
2.813 (8) 15
1.406 (4) 31
.703 (2) 48
.352 (1) 14
U20
74LS175
U30
MC14519
2.813
1.406
.703
.352
.176 (.8) 30
.088 (.4) 47
.044 (.2) 13
.022 (.1) 29
U21
74LS175
U31
MC14519
.176
.088
.044
.022
PART OF 783878
.011 (.08) 46
.005 (.04) 12
.0027 (.02) 28
.0014 (.01) 45
U22
74LS175
U32
MC14519
.011
.005
.0027
.0014
R27 3.3K
+5V
U8 LA3333
J6, PIN 30
R28 10K
R29 10K
LLZ 42
LLI 41
REF 40
S/R 1
U17
74LS175
U40
MC14519
U26
MC14555B
U25 74LS32
J3 J4
J7
ISOI
STROBE



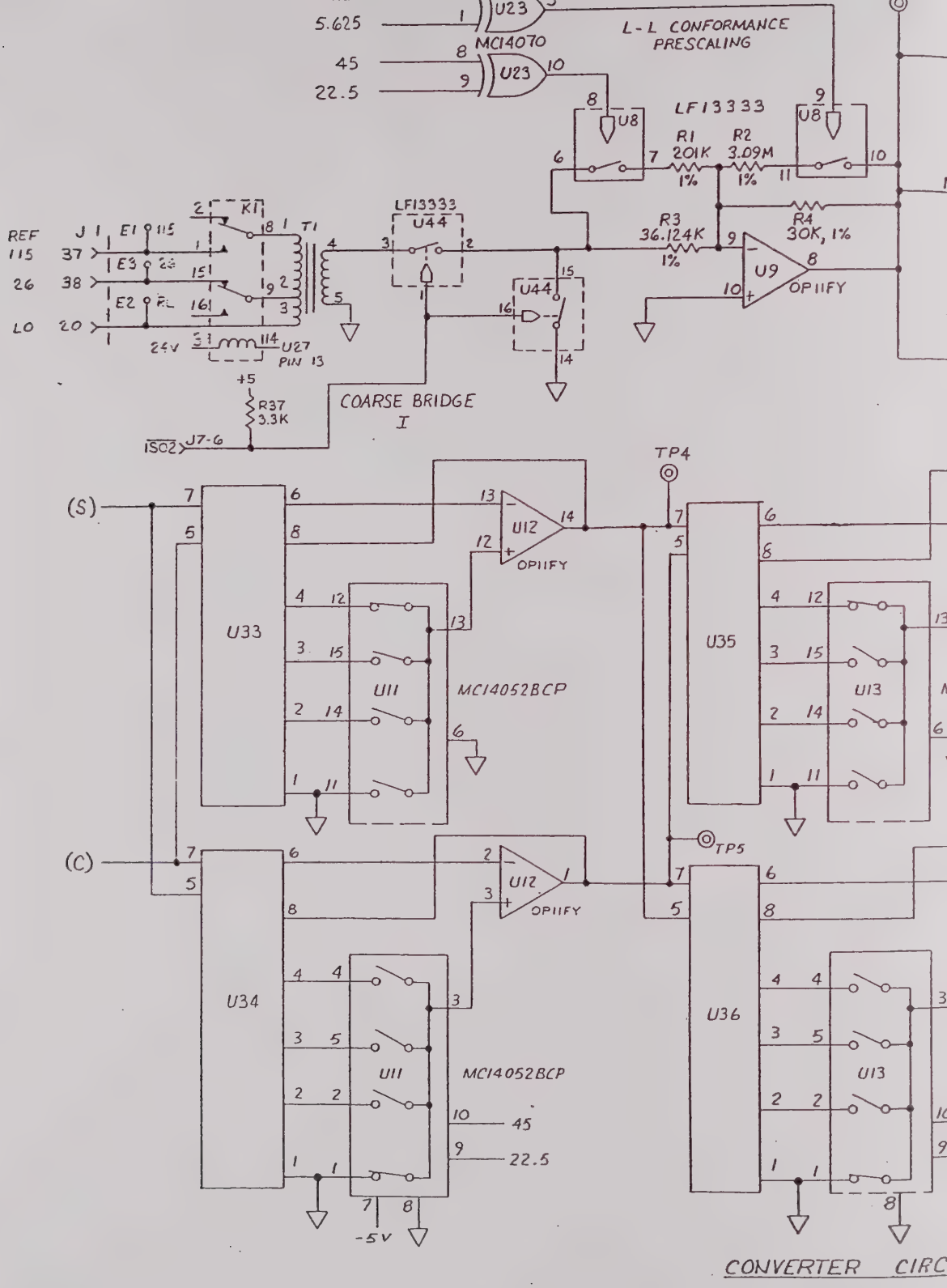
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, 1/4 W, ±5%
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL DIODES ARE 1N4001
4. K10 AND CR28 ARE NOT USED
5. FOR IEEE-488 INTERFACES (F1=2 OR 3), CUT AT JP1

THE FOLLOWING ARE MATCHED COMPONENTS:
R1, R3, R4 - 808874
U10, RT1, RT2 - 500960
C7, C8 - 808958

IC	24	GND	+5	-5	+15	-15
U8, U14, U16	-	4	—	—	12	5
U9, U12, U15	-	—	—	—	4	11
U10	-	3	—	—	16	—
U11, U13	-	8	16	7	—	—
U17-U22	-	8	16	—	—	—
U23	-	7	14	—	—	—
U24	-	—	—	—	14	7
U25	-	7	14	—	—	—
U26	-	8	16	—	—	—
U27	-	8	—	—	—	—
U28-U32, U40	-	8	16	—	—	—
K1-K9	-	—	—	—	—	—

POWER TABLE

Figure 8-2. Main CCA - A1A1, Schematic Diagra
761794-1/A (Sheet 1 of 3)


5.625
45
22.5
MCI4070
U23
L-L CONFORMANCE PRESCALING
LF13333
U8
R1 201K 1%
R2 3.09M 1%
R3 36.124K 1%
R4 30K, 1%
U9
OP11FY
U44
REF
LO
J1
E1
E2
E3
K1
T1
24V
U27 PIN 13
+5
R37 3.3K
ISO2
J7-6
COARSE BRIDGE I
TP4
TP5
(S)
(C)
U33
U34
U35
U36
U11
U12
U13
MCI4052BCP
-5V
CONVERTER CIRC

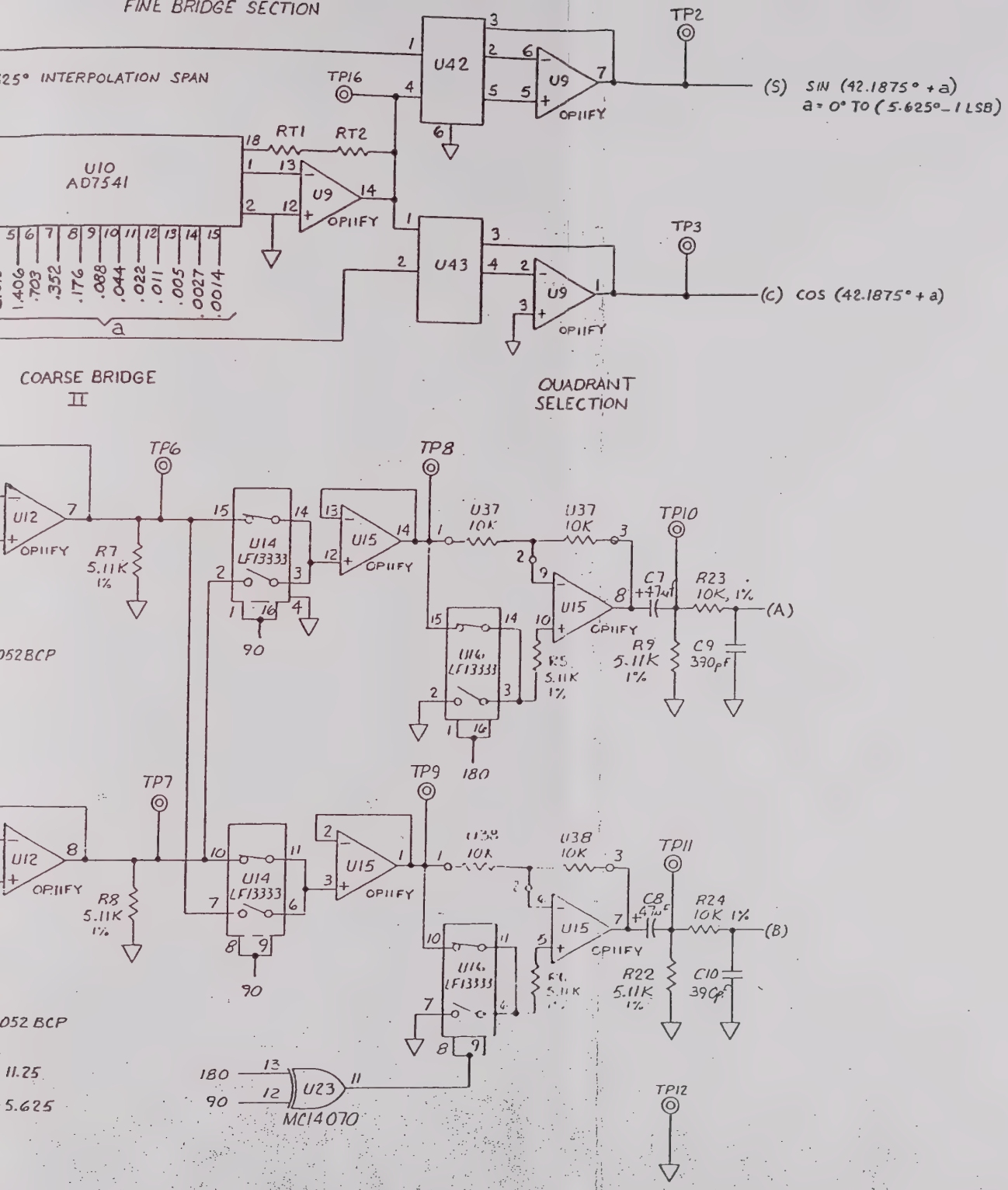
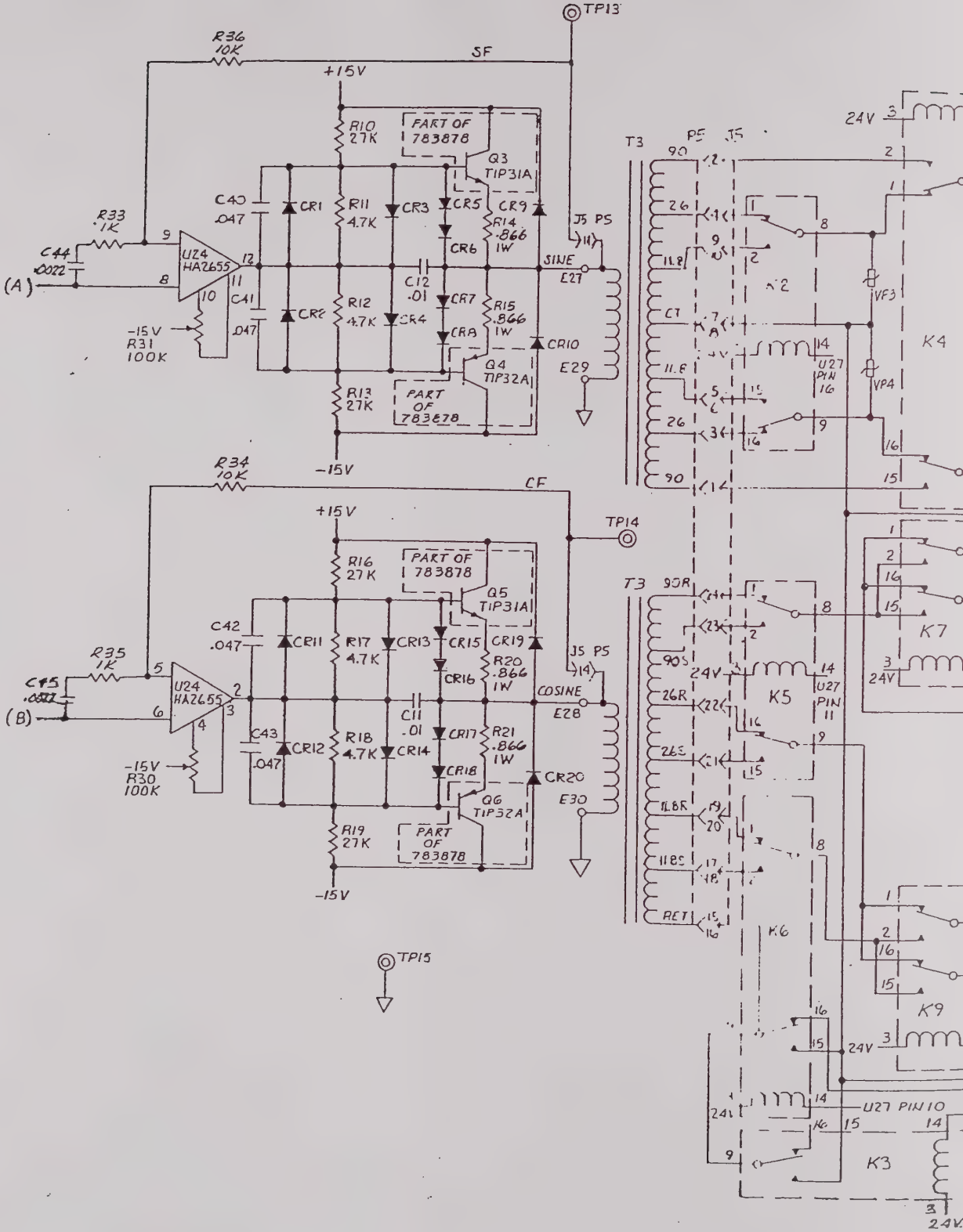
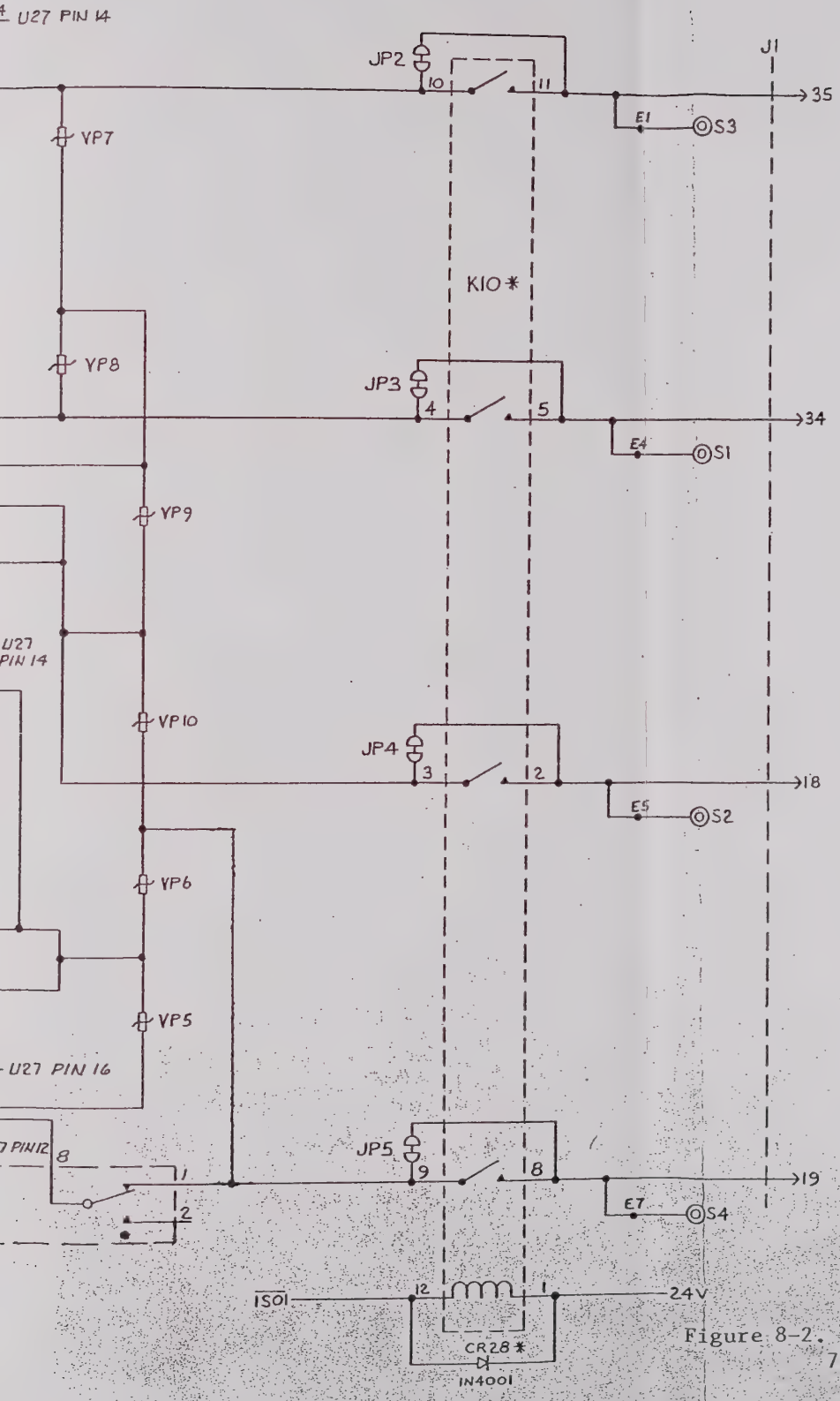


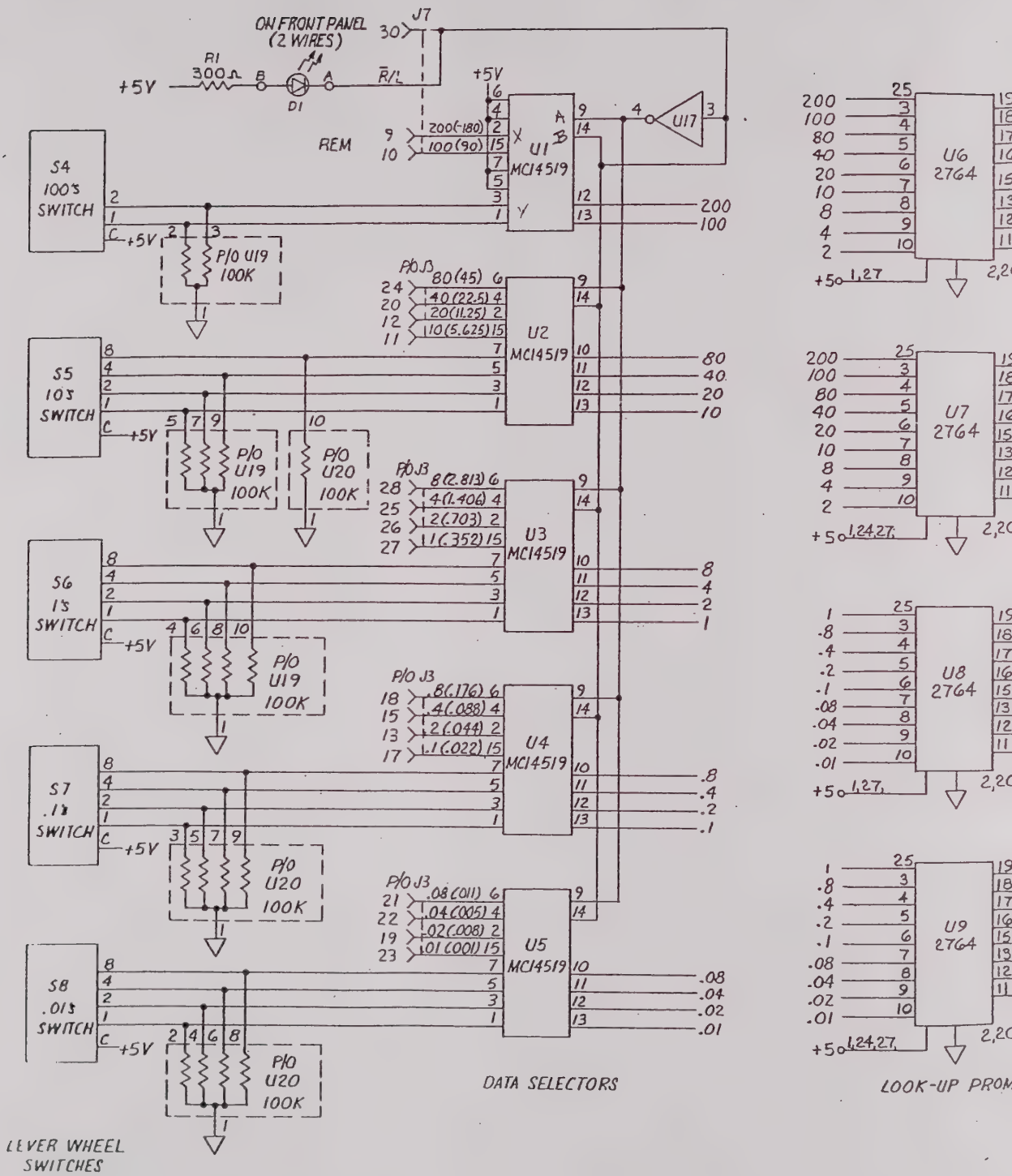
Figure 8-2. Main CCA - A1A1, Schematic Diag
761794-1/A (Sheet 2 of 3)

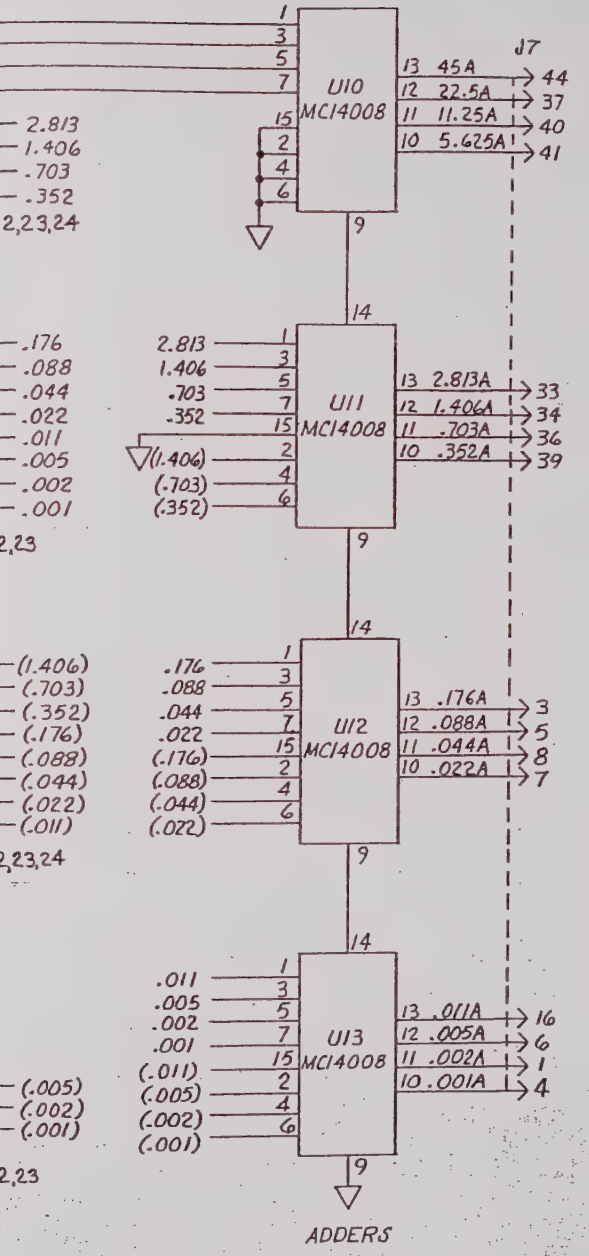

TP13
R36 10K
SF
+15V
R10 27K
PART OF 783878
Q3 TIP31A
C40 .047
CR1
R11 4.7K
CR3
CR5
CR9
R14 .866 1W
CR6
R33 1K
C44 .0022
U24 HA2655
(A)
-15V R31 100K
C41 .047
CR2
R12 4.7K
CR4
C12 .01
CR7
CR8
R15 .866 1W
CR10
Q4 TIP32A
R13 27K
PART OF 783878
-15V
J5 PS
SINE
E27
E29
T3
P5
J5
24V
K2
K4
VP3
VP4
U27 PIN 16
R34 10K
CF
+15V
TP14
R16 27K
PART OF 783878
Q5 TIP31A
C42 .047
CR11
R17 4.7K
CR13
CR15
CR19
R20 .866 1W
CR16
R35 1K
C45 .0022
U24 HA2655
(B)
-15V R30 100K
C43 .047
CR12
R18 4.7K
CR14
C11 .01
CR17
CR18
R21 .866 1W
CR20
Q6 TIP32A
R19 27K
PART OF 783878
-15V
J5 PS
COSINE
E28
E30
T3
90R
90S
26R
26S
11.8R
11.8S
RET
K5
K6
K7
K9
K3
U27 PIN 11
U27 PIN 10
TP15



* KIO AND CR28, SEE NOTE 4

Figure 8-2. Main CCA - A1A1, Schematic Dia
761794-1/A (Sheet 3 of 3)


ON FRONT PANEL (2 WIRES)
J7
30
R1
300Ω
B
A
R/L
D1
+5V
REM
9
10
200(-180)
100(90)
U1
MC14519
X
Y
A
B
U17
S4
100's SWITCH
S5
10's SWITCH
S6
1's SWITCH
S7
.1's SWITCH
S8
.01's SWITCH
C
+5V
P/O U19 100K
P/O U20 100K
P/O J3
80(45)
40(22.5)
20(11.25)
10(5.625)
8(2.813)
4(1.406)
2(.703)
1(.352)
.8(.176)
.4(.088)
.2(.044)
.1(.022)
.08(.011)
.04(.005)
.02(.008)
.01(.001)
U2
MC14519
U3
MC14519
U4
MC14519
U5
MC14519
200
100
80
40
20
10
8
4
2
1
.8
.4
.2
.1
.08
.04
.02
.01
DATA SELECTORS
LEVER WHEEL SWITCHES
U6
2764
U7
2764
U8
2764
U9
2764
+5o
1,27
1,24,27,
2,20
LOOK-UP PROM

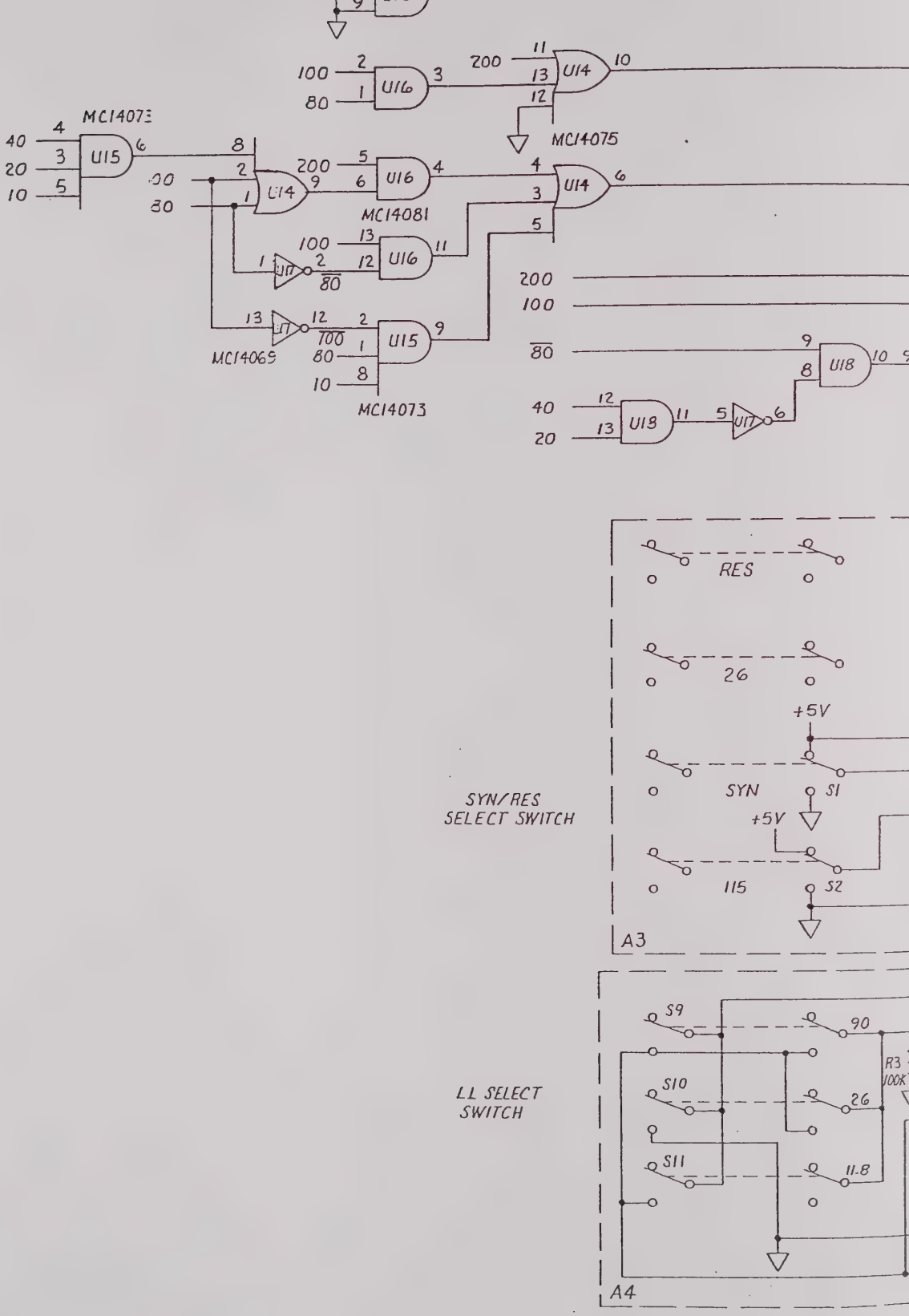


POWER TABLE

IC	-5	GND	+5	+12
U1-U5	—	8	16	—
U6-U9	—	14	28	—
U10-U13	—	8	16	—
U14	—	7	14	—
U15	—	7	14	—
U16, U18	—	7	14	—
U17	—	7	14	—

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4 W ±5%.
2. ALL CAPACITOR VALUES ARE IN MICRO FARADS.

Figure 8-3. BCD/Binary Converter CCA - A2, Schematic Diagram 761793/D (Sheet 1 of 2)


MC14073
U15
U14
U16
U17
U18
MC14081
MC14069
MC14073
MC14075
40
20
10
100
80
200
SYN/RES
SELECT SWITCH
RES
26
+5V
SYN
S1
115
S2
A3
LL SELECT
SWITCH
S9
90
S10
26
S11
11.8
R3
A4

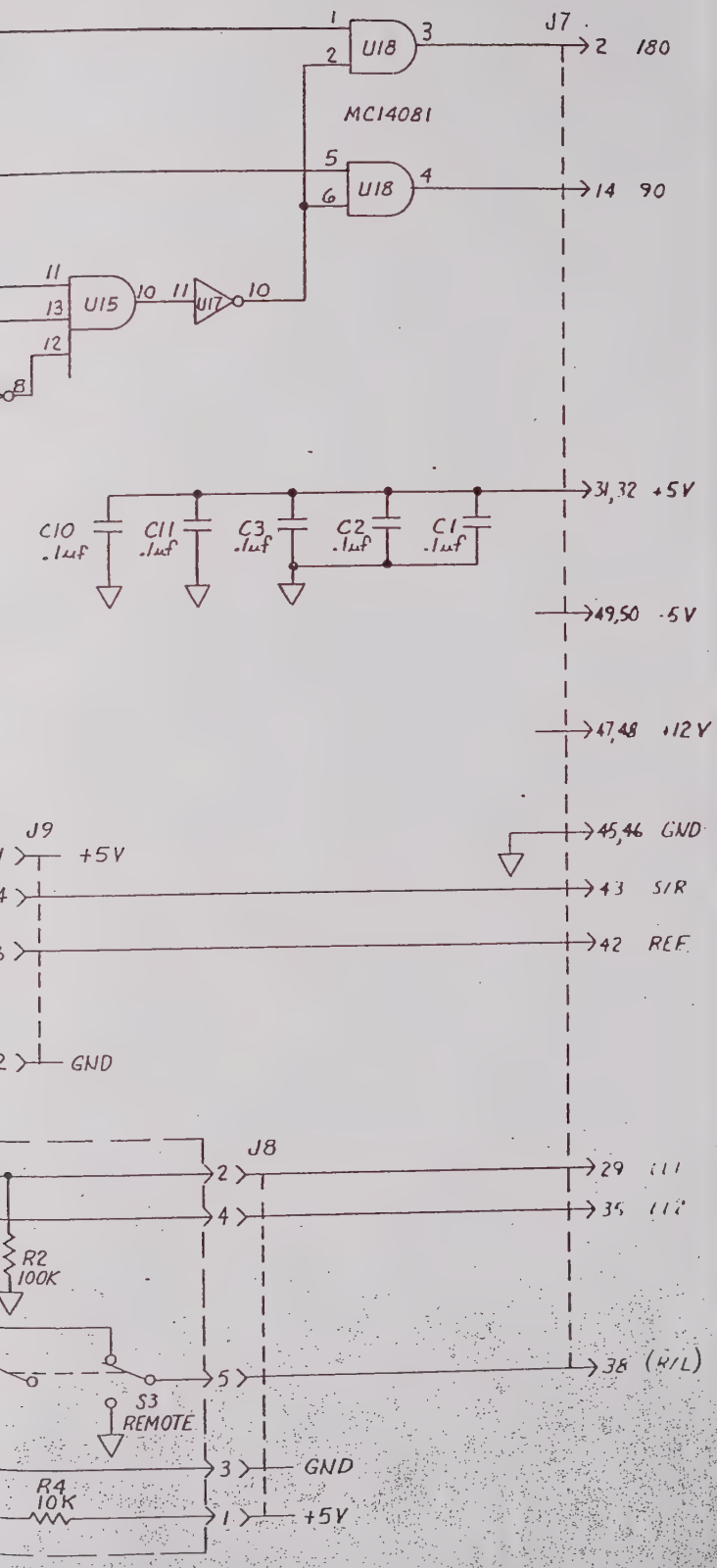
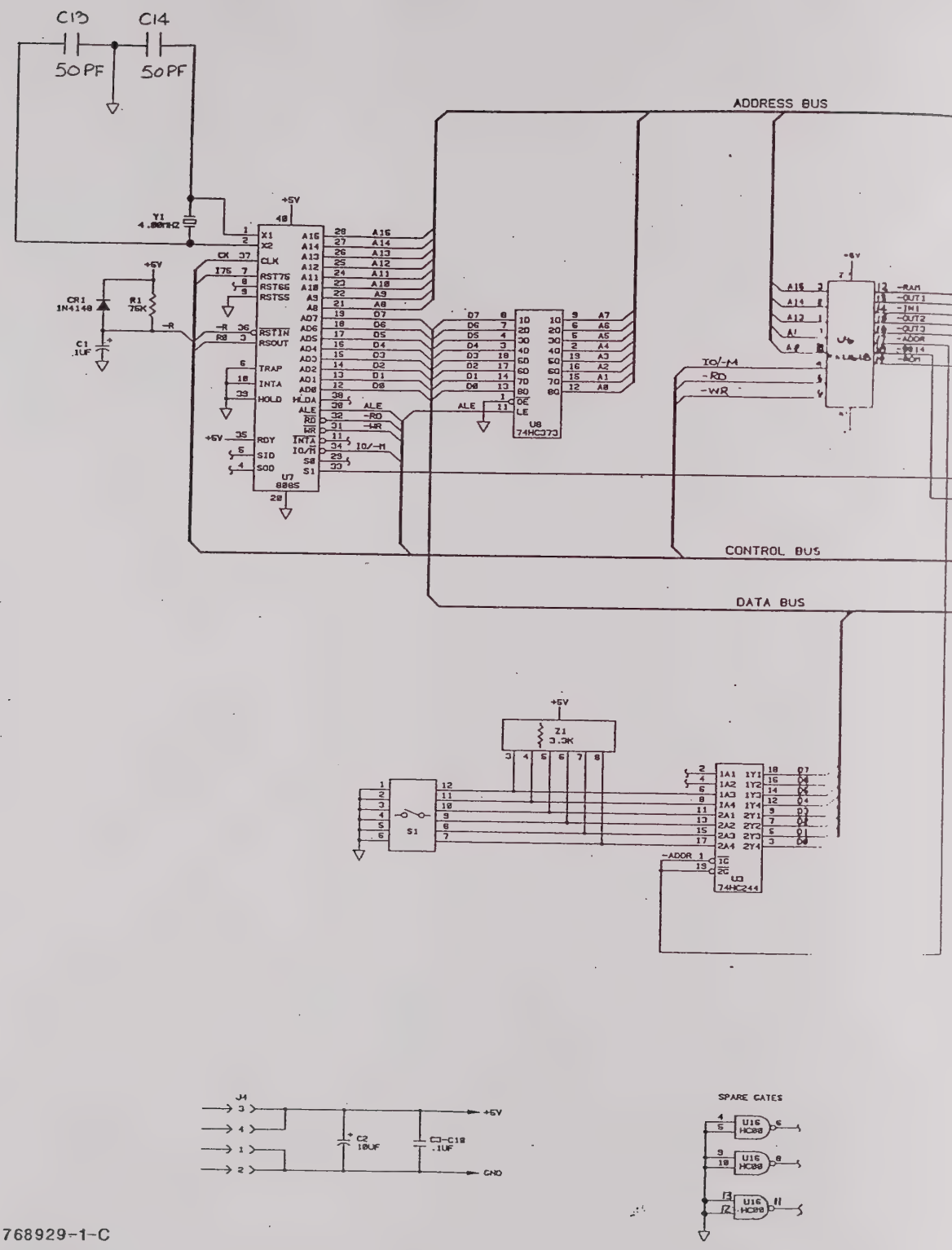


Figure 8-3. BCD/Binary Converter CCA – A
Schematic Diagram 761793/D (Sheet 2 of 2


C13
C14
50 PF
50 PF
ADDRESS BUS
CONTROL BUS
DATA BUS
Y1
4.00MHZ
+5V
CR1
1N4148
R1
75K
C1
.1UF
U7
8085
U8
74HC373
U3
74HC244
Z1
3.3K
S1
-ADDR
IO/-M
-RD
-WR
ALE

J4
+5V
C2
10UF
C3-C18
.1UF
GND

SPARE GATES
U16
HC08

768929-1-C

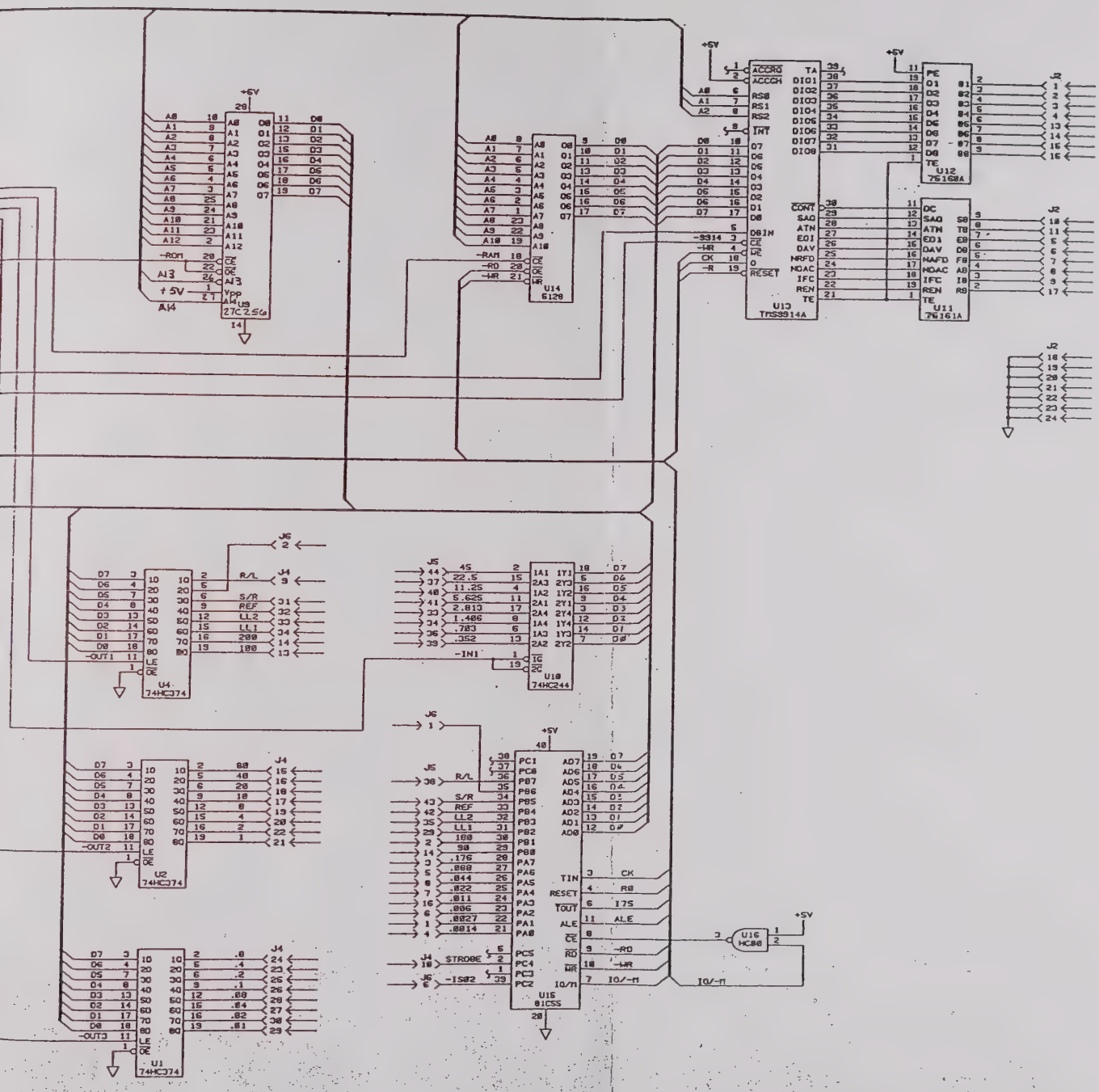
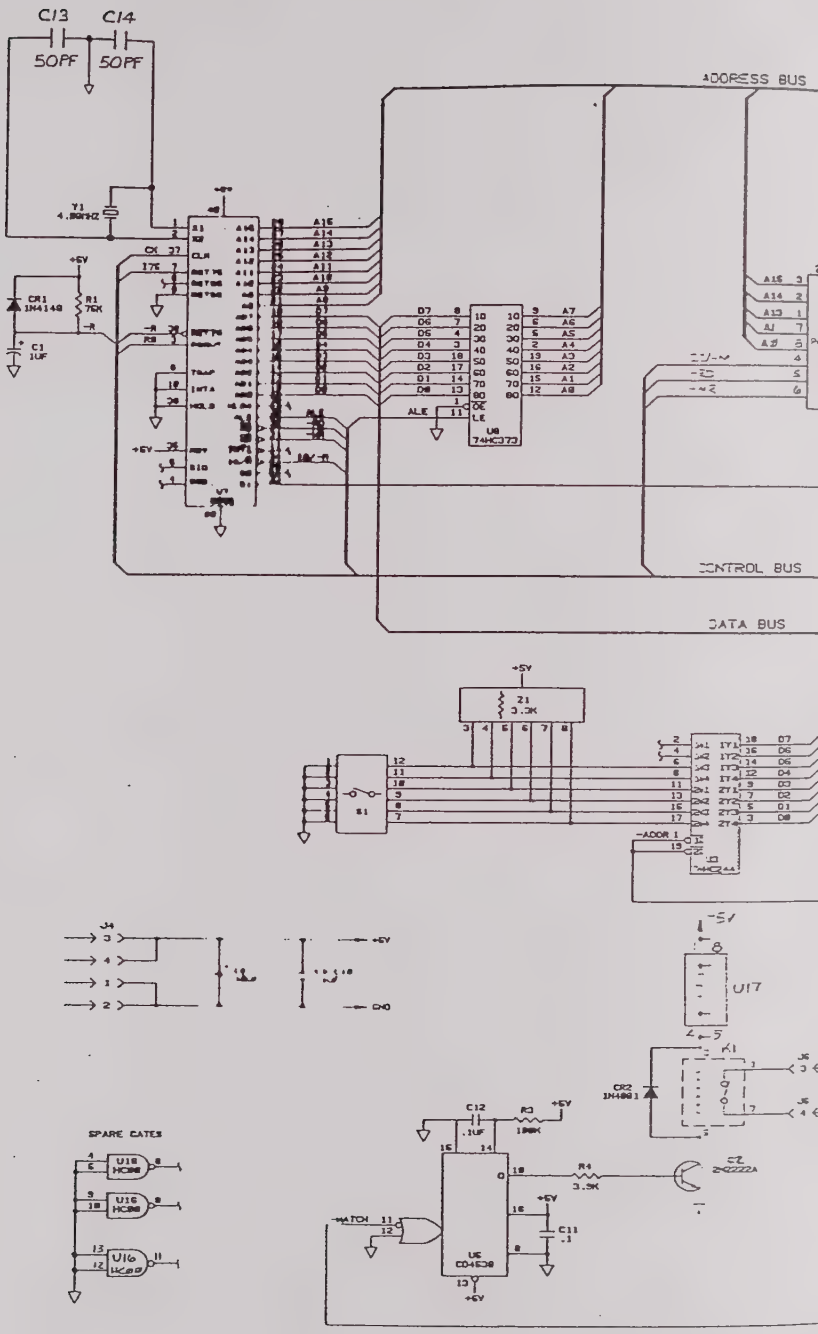


Figure 8-4. IEEE-488 Interface
CCA-A3, Schematic Diagram


C13
C14
50PF
50PF
ADDRESS BUS
CONTROL BUS
DATA BUS
+5V
U17
SPARE GATES

768929-2-D

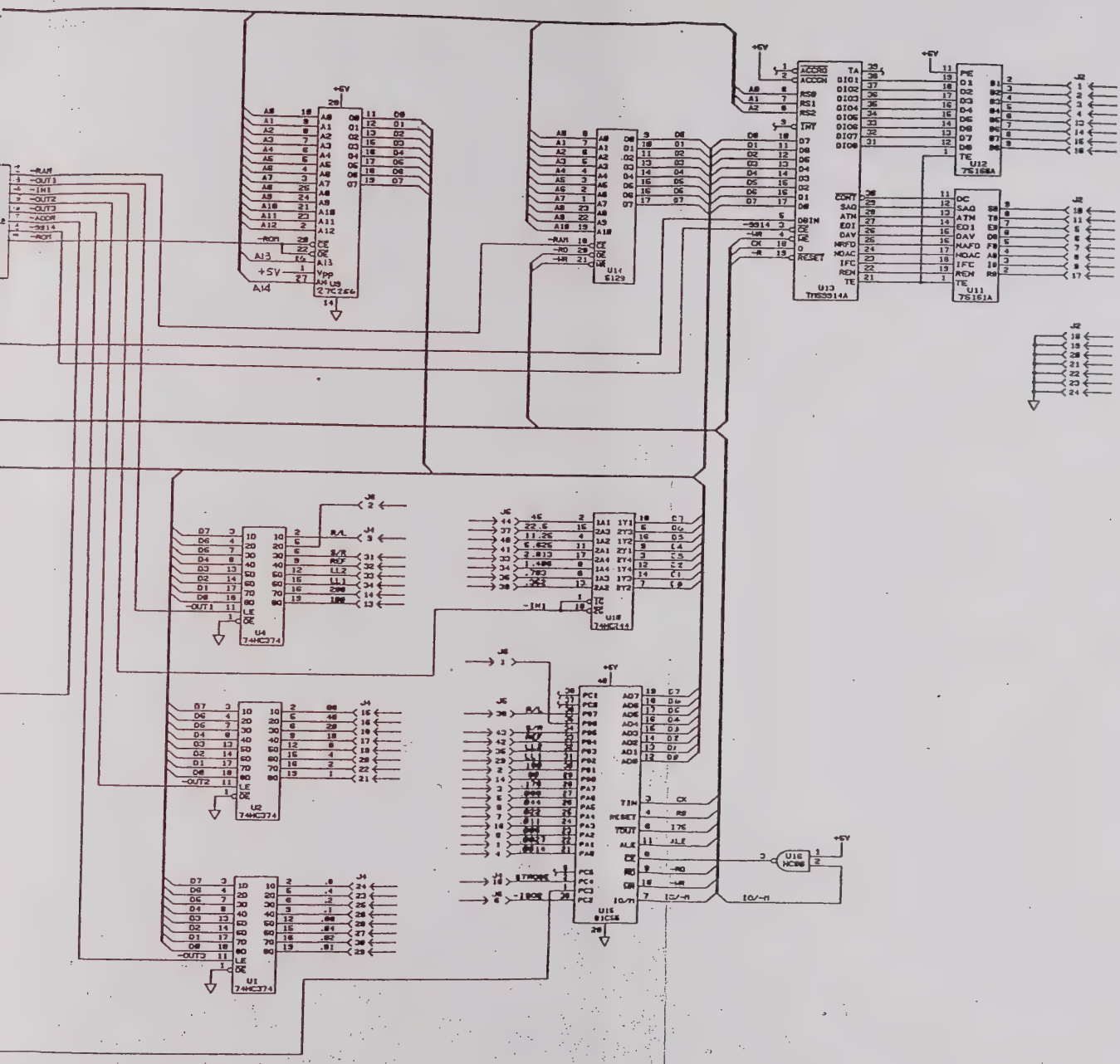


Figure 8-5. IEEE-488 MATE/CIIL
CCA-A3, Schematic Diagram

SECTION 9

UPDATE INFORMATION

9-1 INTRODUCTION

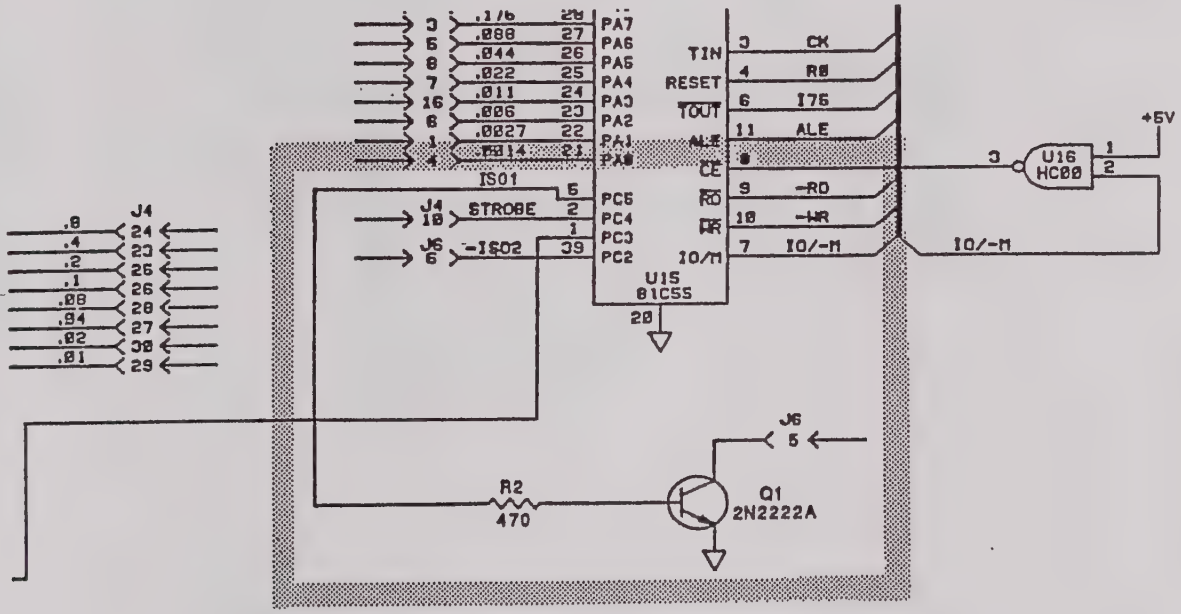
As NAI continues to improve the performance of the Model 5310 SIM, corrections and modifications to the manual may be required. This section contains Product Revision Sheet (PRS) data which updates the unit to the most current configuration available.

1.0 ASSEMBLIES AND REVISION LEVELS AFFECTED:

IEEE-488 MATE/CIIL CCA A3 - NAI P/N 787467-2 Revision D1

2.0 CHANGES:

In SECTION 8 change figure 8-5 as shown:



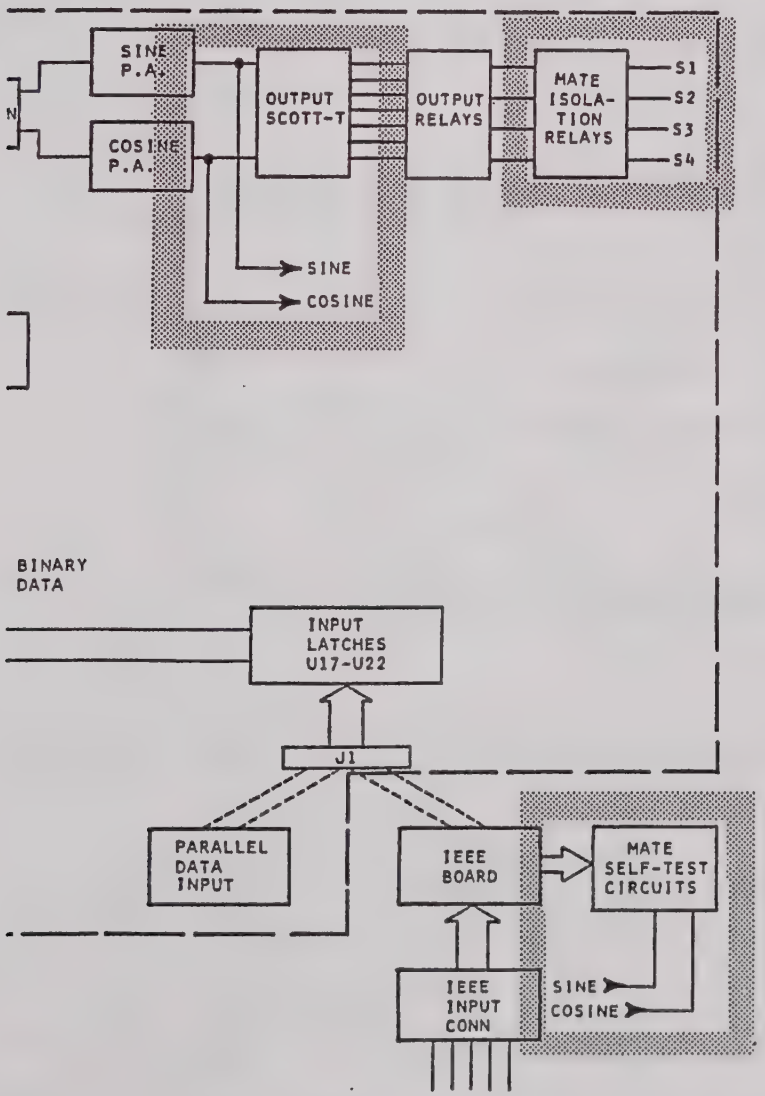
1.0 ASSEMBLIES AND REVISION LEVELS AFFECTED:

1.1 Top Assembly NAI P/N 405310 Revision F and higher.
1.2 Chassis Assembly A1 NAI P/N 783878 Revision F and higher.
1.3 Main Circuit Card Assembly (CCA) A1A1 NAI P/N 783871-1 Revision A and higher.
1.4 IEEE-488 Interface CCA A3 NAI P/N 787467-1 Revision C and higher.
1.5 IEEE MATE/CIIL Interface CCA A3 NAI P/N 787467-2 Revision C and higher.
1.6 IEEE MATE/CIIL Self-Test CCA A4 NAI P/N 789134 Revision A and higher.

2.0 CHANGES:

2.1 In SECTION 1 - GENERAL INFORMATION paragraph 1-7, table 1-3 add 5310 IEEE MATE/CIIL Self-Test CCA A4 789134/A.

2.2 In SECTION 4 - THEORY OF OPERATION change figure 4-3 as shown:



2.3 In SECTION 5 - MAINTENANCE change the following:

2.3.1 In paragraph 5-3 delete paragraph 5-3.3 and add the following subparagraphs:

5-3.3 Removal of IEEE MATE/CIIL Self-Test CCA*. Remove IEEE MATE Self-Test CCA A4 (30) as follows:

a. Disconnect cable assembly (F) from A4J2 and cable assembly (G) from A4J1.

b. Remove two screws (31), lockwashers (32), and flat washers (33) securing Self-Test CCA A4 from IEEE-488 CCA A3.

c. Depress tang of plastic standoff and lift circuit card up.

d. To replace IEEE MATE/CIIL Self-Test CCA, reverse removal procedure.

5-3.4 Removal of IEEE-488 CCA*. Remove the IEEE-488 CCA (5) as follows:

a. Remove IEEE MATE/CIIL Self-Test CCA A4 (paragraph 5-3.3).

b. Disconnect cable assemblies (A), (E), and (F) from IEEE-488 CCA.

c. Unscrew two screws (6) from the rear panel and two screws (14) securing the circuit card to the mounting brackets.

d. Lift card carefully and disconnect cable assembly (B) from Main CCA (28).

e. Remove the IEEE-488 CCA.

f. To replace IEEE-488 CCA, reverse removal procedure.

*Optional unit

2.3.2 Replace paragraph 5-4 with the following:

5-4 ALIGNMENT PROCEDURES

The alignment procedures required for the Model 5310 are the offset adjustment of the output amplifiers and frequency adjustments for the optional IEEE MATE/CIIL Self-Test circuits.

5-4.1 Output Amplifier Offset Adjustment.

a. Remove Scott-T transformer A1T3 (paragraph 5-3.5).

NOTE

The following procedure is performed on the Main CCA.

b. Install jumpers between E27 and TP13 and between E28 and TP14.

c. Short TP10 to ground.

d. Connect DVM to TP13 and adjust R30 for a DVM reading below 0.1 mV (adjust as close as possible to 0 V dc).

e. Remove short from TP10 to ground and apply short from TP11 to ground.

f. Connect DVM to TP14 and adjust R31 for a DVM reading below 0.1 mV (adjust as close as possible to 0 V dc).

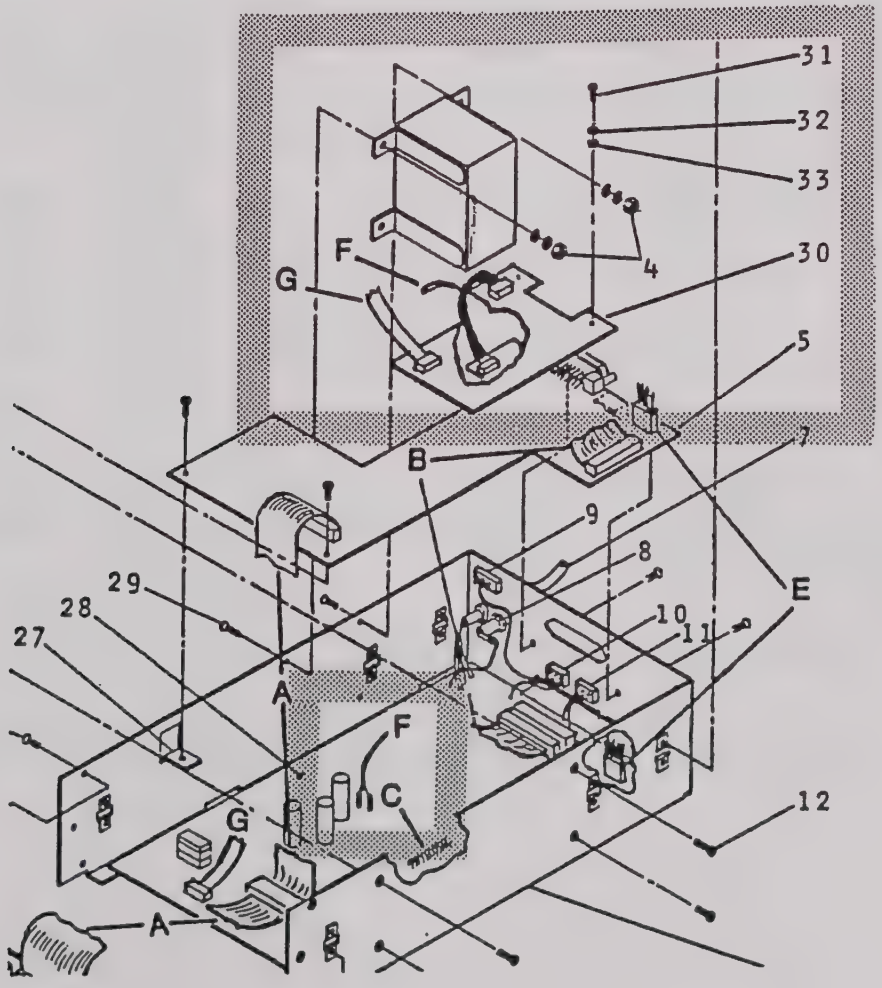
g. Remove jumpers connected in step b and short connected in step e. Reinstall Scott-T transformer A1T3.

5-4.2 IEEE MATE/CIIL Self-Test CCA Frequency Adjustment.

a. Connect frequency counter to A4TP2 (HI) and A4TP12 (LO).

b. Adjust resistor A4R9 for a frequency reading of 1.0 kHz ±30 Hz.

2-3.3 Change figure 5-1 as shown:



2.3.4 Add the following to the figure 5-1 legend:

LEGEND

30 - IEEE MATE SELF-TEST CCA A4

CABLE LEGEND

F - SELF-TEST CCA TO IEEE-488 CCA
G - SELF-TEST CCA TO MAIN CCA

2.4 In SECTION 7 - PARTS LIST change the following:

2.4.1 In table 7-4 add the following:

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N
A4	IEEE MATE/CIIL Self-Test CCA	789134	07342	789134
A4J2	Socket, 16-pin	808197	00779	2-640358-3
A4W1	5310 Self-Test Cable Assembly #1	180168	07342	180168
A4P101, A4P102	Connector, Plug, 16-pin DIP	884973	76381	3416-0000
A4W2	5310 Self-Test Cable Assembly #2	180169	07342	180169
A4P103	Housing, Mini-Latch, 6-pin	882702	22526	65039-031
A4P104	Housing, Mini-Latch, 4-pin	808450	22526	65039-033
K10	Relay, 4 PST, 24 V	888950	61529	S4EB-24

2.4.2 Replace figure 7-1 as shown in this addendum.

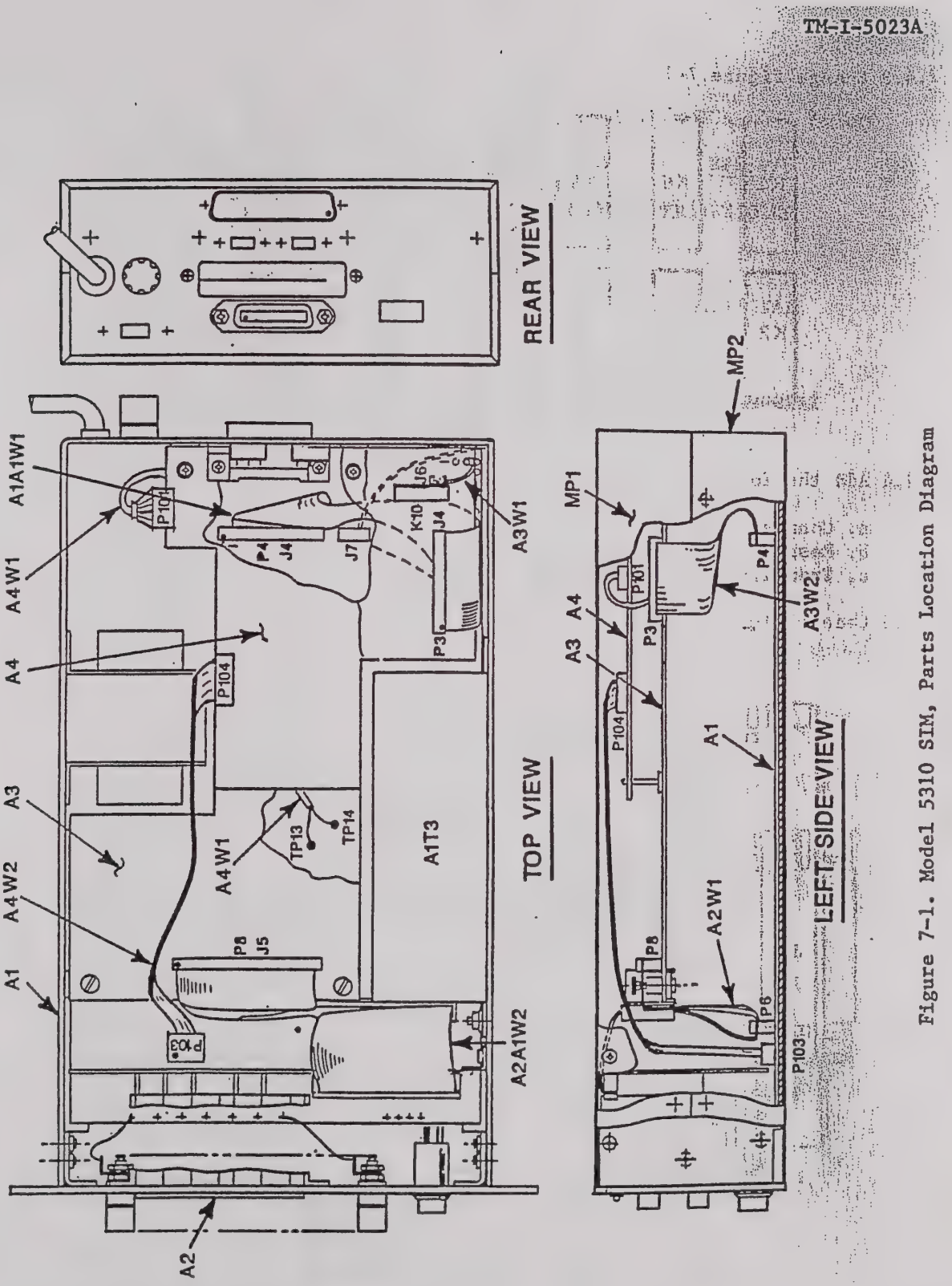
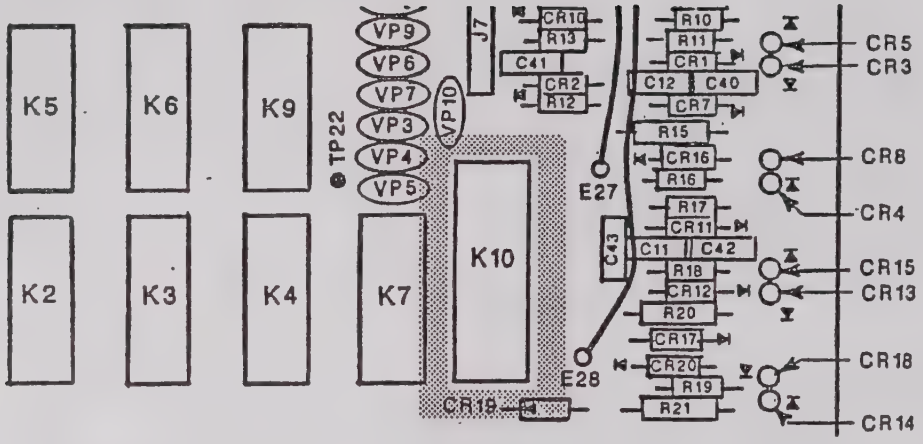


Figure 7-1. Model 5310 SIM, Parts Location Diagram

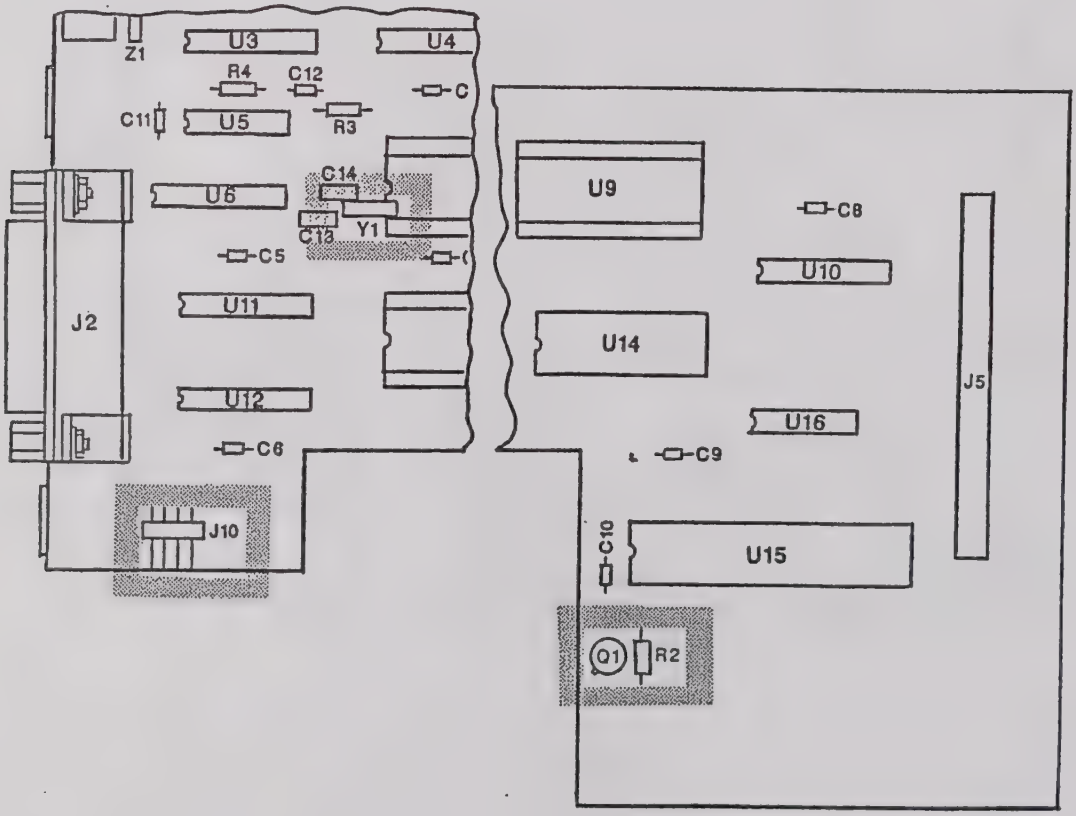
2.4.3 Change figure 7-3 as shown:



2.4.4 Add the following to table 7-17:

a. Connector J10, 36-pin NAI P/N 886058.
b. Resistor, R2, 470 ohms, NAI P/N 880567.
c. Transistor, Q1, 2N2222, NAI P/N 805062.

2.4.5 Change figure 7-13 as shown:



2.4.6 Add Table 7-18 replacement parts list as follows:

Table 7-18. Replacement Parts List - IEEE MATE/CIIL Self-Test CCA A4 - 789134

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N	UOC
C1	Capacitor, Ceramic, 0.01 uf, 100 V, ±10%, Axial Leads	887766	90201	CKR11BX103KP	
C2	Capacitor, Ceramic, 0.0015 uf, 100 V, ±10%, Axial Leads	886733	96095	SA101C152KAA	
C3	Capacitor, Tantalum, 47 uf, 25 VDC, ±10%	884614	56289	1990476X902EA2	
C4	Same as C3				
C5	Same as C3				
C6,C7	Same as C1				
C8	Same as C3				
C9	Same as C1				
CR1	Diode, Signal In, DO35	808974	07263	1N4148	
J1	Socket, 16-pin DIP	808197	00779	2-640358-3	
J2	Terminal Strip, Right Angle, 6-pin	886058	27014	LM361N	
R1	Resistor, Metal Film, 13.3 k, 1/10 W, ±1%	807633	91637	MF 1/10 13.3K 1%	
R2	Resistor, Metal Film, 9.53 k, 1/8 W, ±1%	805400	16299	Type C4	
R3	Resistor, Metal Film, 7.68 k, 1/10 W, ±1%	808369	01121	CC7681F	
R4	Resistor, Metal Film, 6.65 k, 1/10 W, ±1%	806339	55182	RNR55C6651FM	
R5	Resistor, Metal Film, 75 ohm, 1/10 W, ±1%	887067	81349	RN55D750F	
R6	Same as R5				
R7	Resistor, Metal Film, 453 k, 1/10 W, ±1%	888879	81349	RN55D4533F	

Table 7-18. Replacement Parts List - IEEE MATE/CIIL Self-Test CCA A4 - 789134 (Continued)

REF DES	DESCRIPTION	NAI P/N	FSCM	MFR P/N	UOC
R8	Resistor, Metal Film, 1 k, 1/8 W, ±1%	882479	81349	RNR55E1001FS	
R9	Resistor, Variable, 100 k, ±10%, 25 Turns	807062	32997	3299W104	
TP1	Post	880007	00779	87022-9	
TP2-TP12	Same as TP1				
U1	IC, Dual Differential Comparator, 8-pin DIP	884448	12040	LM393N	
U2	IC, High Speed CMOS, Dual Binary 4-bit Counter, 14-pin DIP	888954	04713	MC74HC393	
U3	IC, CMOS, Timer, 8-pin	888953	82647	TLC555C	
U4	IC, 1 of 8 Analog Multiplexer, 16-pin DIP	888952	17856	DG508ACJ	
U5	IC, Quad Op-Amp, 14-pin DIP	808496	17856	TL084	
U6	IC, Analog Switch, Dual 4 to 1 Multiplexer, 16-pin DIP	886030	17856	DG509ACJ	
U7	IC, Linear Quad Analog Switch, 16-pin DIP	808733	12040	LF13333N	
Z1	Resistor, Network, 5.6 k, 8-pin, SIP	888956	01121	708B562	
Z2	Same as Z1				
Z3	Resistor, Network, 10 k, ±2%, 10-pin SIP	808481	32997	4310R-102-103	

2.4.7 Add figure 7-14 as shown:

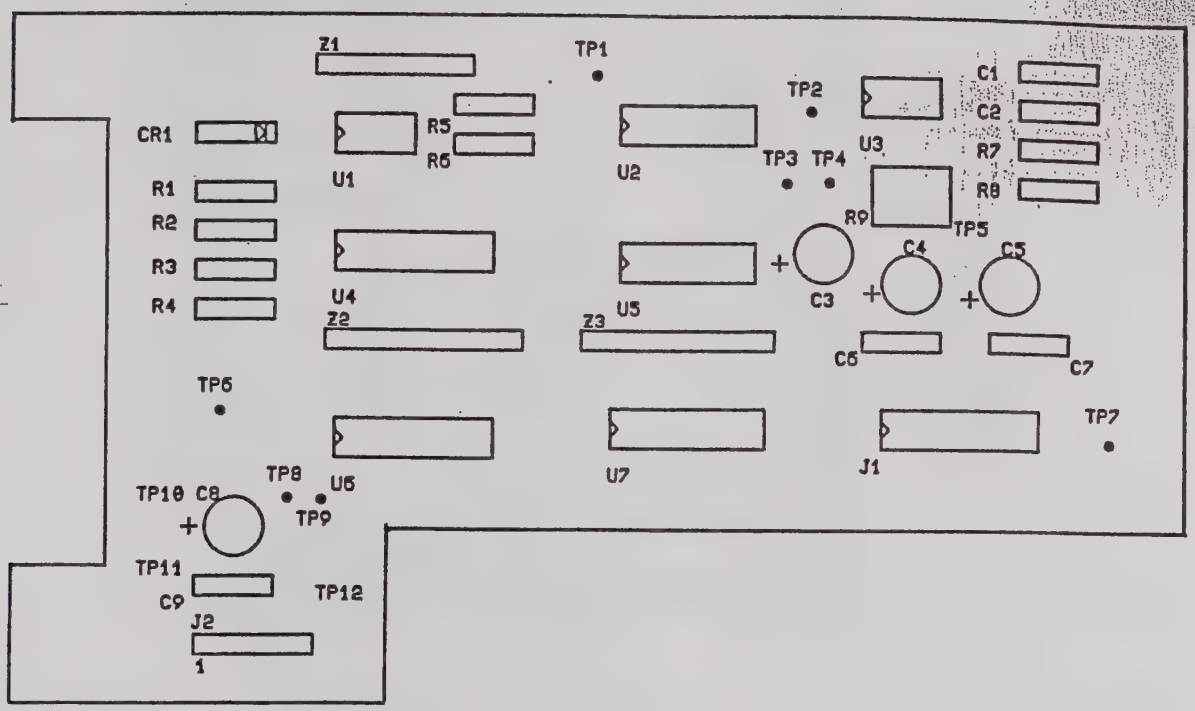


Figure 7-14. IEEE MATE/CIIL Self-Test CCA A4 (P/N 789134), Parts Location Diagram

2.4.8 Add the following manufacturer information accordingly throughout the manual:

Code	Name and Address
52464	OKI Electronics of America 4031 NE 12th Terrace Ft. Lauderdale, Florida 33334
61529	Aromat 250 Sheffield Avenue Mountain Side, New Jersey 07092

2.5 In SECTION 8 - SCHEMATIC DIAGRAMS change the following:

2.5.1 In paragraph 8-1 add the following figure title:

Figure	Title	Page
8-6	IEEE MATE/CIIL Self-Test CCA A4	8-21

2.5.2 Change figure 8-1 (Sheet 2 of 2) as shown in this addendum.

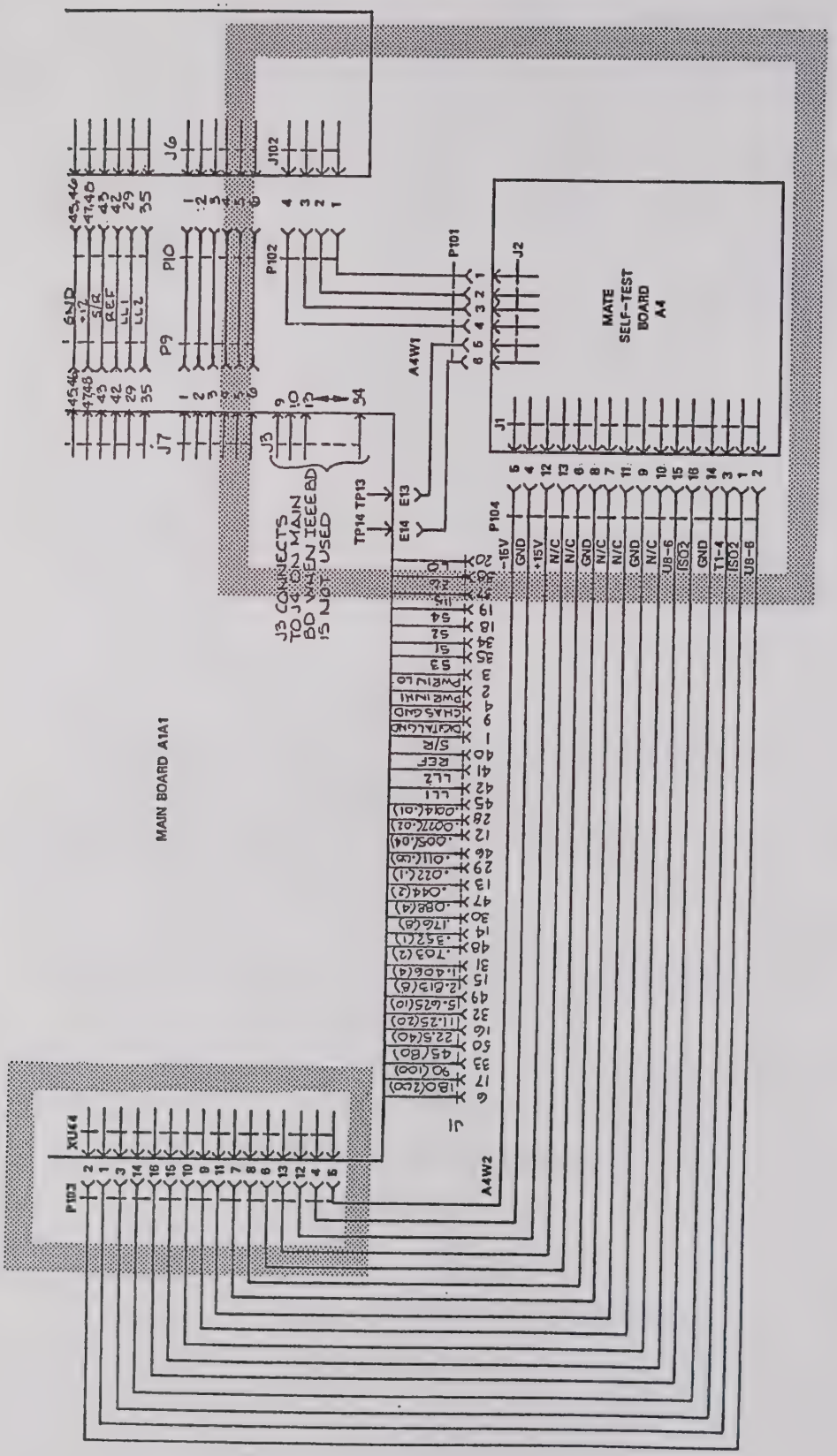
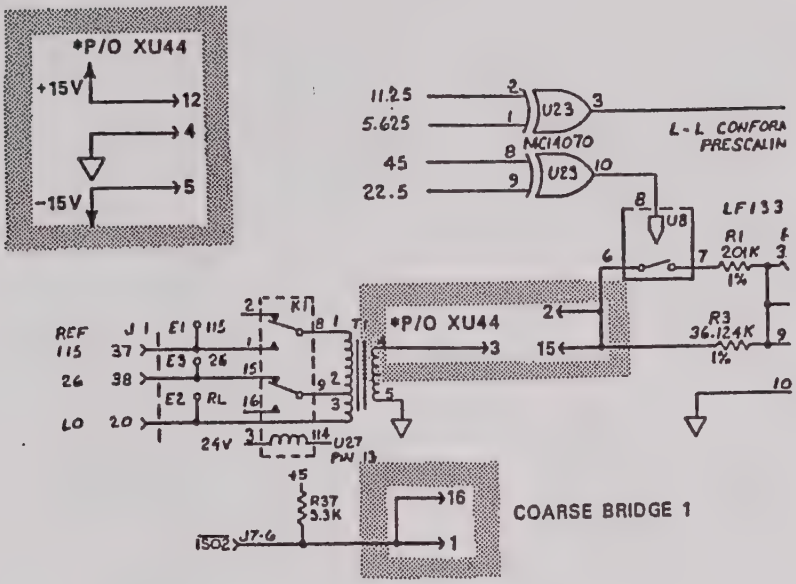


Figure 8-1. Model 5310 Interconnection Diagram 761798/E (Sheet 2 of 2)

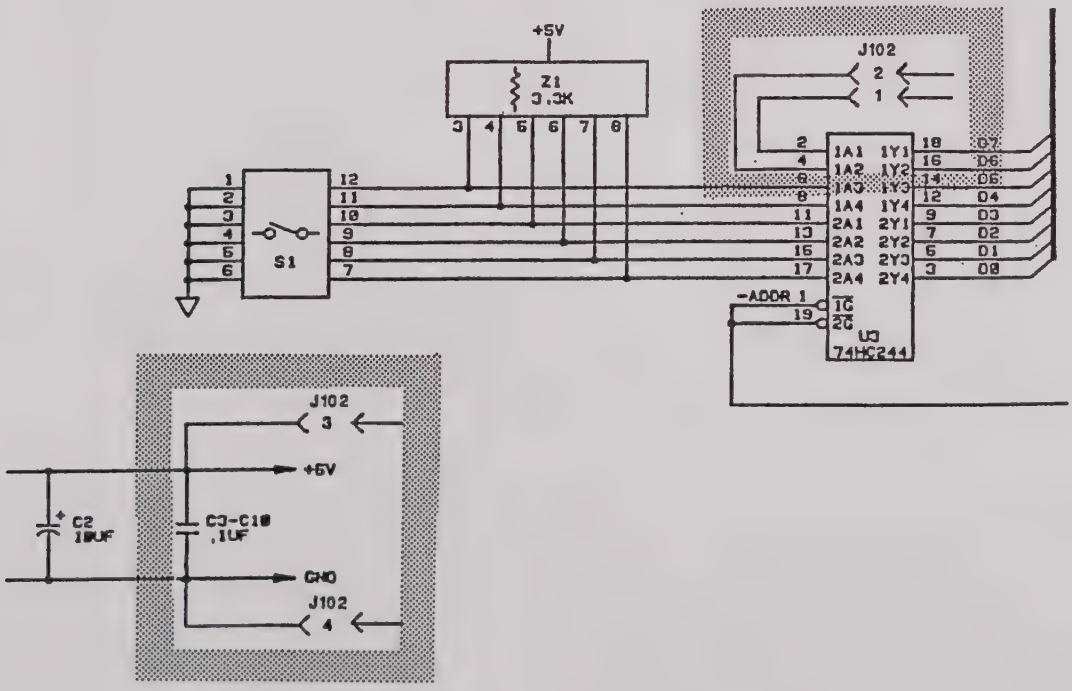
2.5.3 Change figure 8-2 (Sheet 2 of 3) as shown:



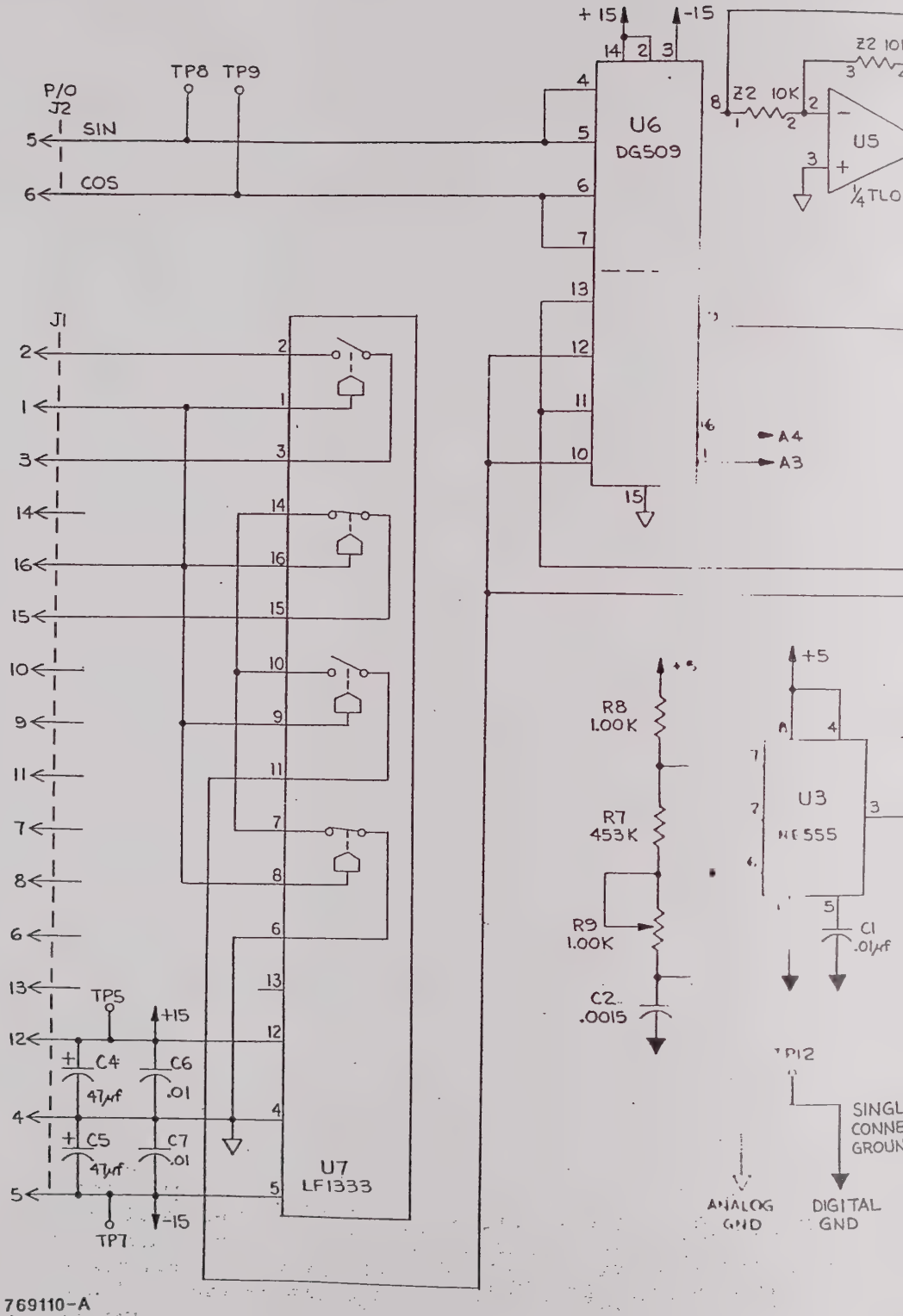
*See Figure 8-1 Interconnection Diagram (Sheet 2 of 2) in this addendum for XU44 connections.

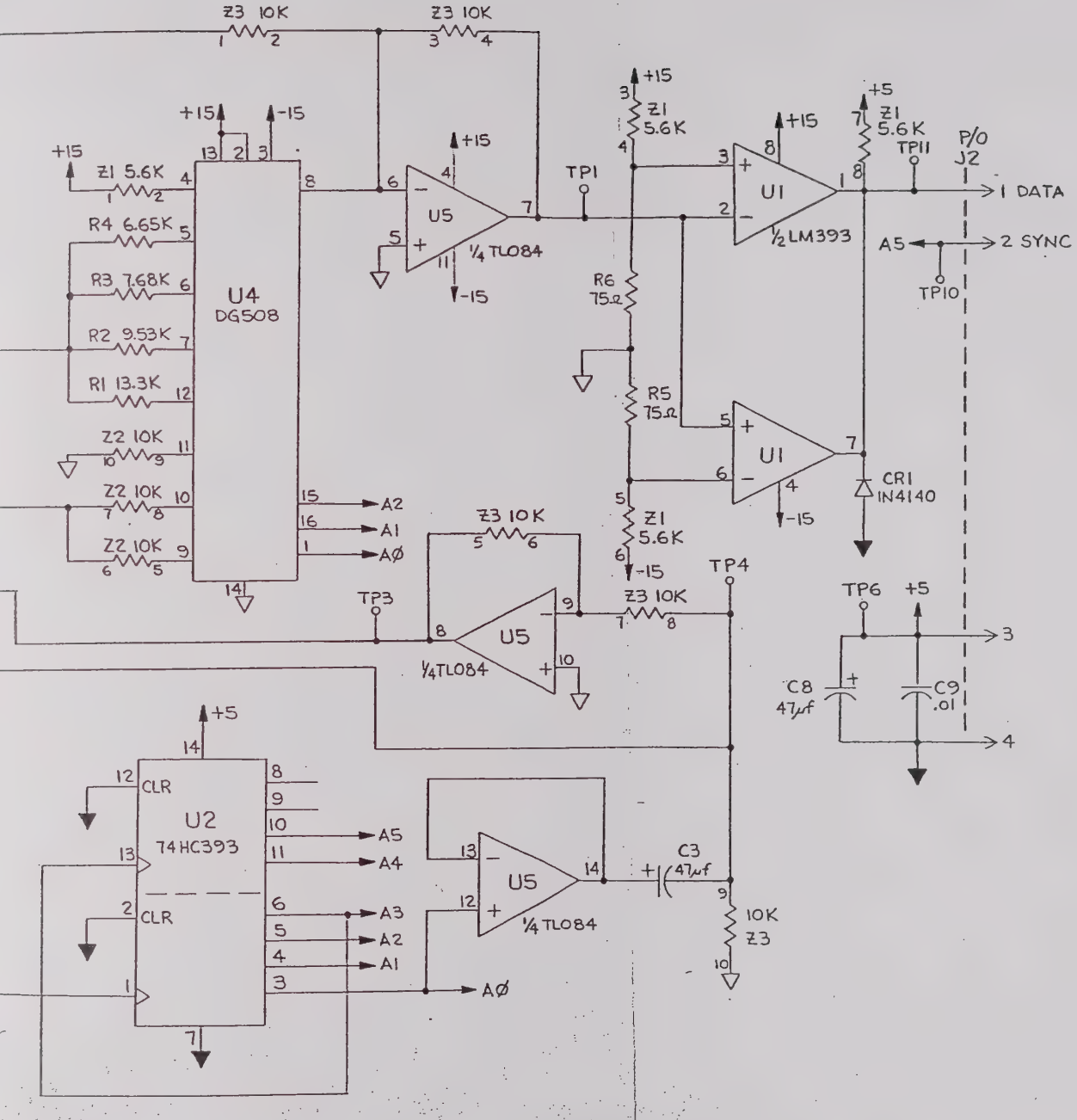
2.5.4 Change title of Figure 8-4 to: IEEE-488 CCA A3, Schematic Diagram.

2.5.5 Change figure 8-5 as shown:



2.5.6 Add figure 8-6 as shown in this addendum.


+15
-15
P/O J2
SIN
COS
TP8
TP9
U6
DG509
Z2 10K
U5
1/4 TLO
J1
A4
A3
R8 1.00K
R7 453K
R9 1.00K
C2 .0015
U3
NE555
C1 .01µf
+5
TP5
C4 47µf
C6 .01
C5 47µf
C7 .01
U7
LF1333
TP7
TP12
SINGL
CONNE
GROUN
ANALOG GND
DIGITAL GND
769110-A



OINT
N BETWEEN
AT J1-4, J2-4

Figure 8-6. IEEE MATE Self-Tes
CCA - A4, Schematic Diagram

LIMITED WARRANTY

A. The seller warrants products against defects in material and workmanship for twelve months from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

B. The seller specifically excludes from the warranty 1) calibration, 2) fuses, 3) source inspection, 4) test data, 5) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, printheads, recording heads, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

C. The seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of products.

D. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require subsequently manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

F. No other warranty expressed or implied is offered by the seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.

NORTH ATLANTIC SERVICE CENTERS

The following list identifies authorized repair service centers. These centers are authorized to provide warranty service, spare parts sales and out of warranty repairs.

DOMESTIC

Electrical Standards Repair Service
7337 Greenbush Avenue
N. Hollywood, CA 91605
(818) 765-4224
Service Manager

North Atlantic Industries, Inc.
60 Plant Avenue
Hauppauge, NY 11788-3890
(516) 582-6500
Service Manager

Pat Lind Electronics
7411 Lake Drive
P.O. Box 125
Circle Pines, MN 55014
(612) 786-5770
Service Manager

INTERNATIONAL

Applied Measurement Pty. Ltd.
27 Dalgety Street
Oakleigh, Victoria, Australia 3166
(03) 568-0588
Service Manager

Associated Electronics Pty. Ltd.
P.O. Box 31094
Braamfontein 2017
Johannesburg, So. Africa
839-1824
Service Manager

Racom Electronics Co., Ltd.
P.O. Box 21120
Tel-Aviv, Israel 61210
(011) 972-3-491922
Service Manager

Seki Technical Center
3-2-6, Sennin-cho
Hackioji-Shi
Tokyo 193, Japan
(011) 81-42-664-3011
Service Manager

Technitron Sys. England
Redfields Park
Church Crookham
Aldershot, Hampshire
England, GU13 ORD
(011) 44-252-851085
Service Manager

Technitron Sys. France
8, Ave. Aristide Briand
92220, Bagneux, France
(011) 331-4-657-1147
Service Manager

Technictron GmbH Germany
Charles deGaulle Str. 4
D-8000 Munich 83, Germany
(011) 49-89-637-3090
Service Manager

MP MASTER
MA20100